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Influence of edge band material on selected properties of particleboard slats

Wpływ materiału obrzeżowego na wybrane właściwości listew z płyty wiórowej

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Abstract

As part of the research, narrow surfaces of slats made of three-layer laminated chipboard with a density of 600 kg/m^3 and a thickness of 18 mm were covered with edge materials. For this purpose, a PVC edge with a thickness of 1 and 2 mm, an ABS edge with a thickness of 1 and 2 mm, an edge made of paper impregnated with a mixture of urea-formaldehyde resins UF and melamine-formaldehyde resins MF, laminate, American walnut veneers 2 mm thick, unvarnished (raw) and varnished. In addition, a control variant without borders was prepared. The edges were glued to the chipboard with EVA hot melt adhesive. For the prepared samples, selected mechanical properties (MOR, MOE, edge peeling strength) and physical properties (swelling and water absorption after 2 and 24 h of soaking in water) were tested.

Based on the tests, it was found that the use of edges made of PVC and ABS with a thickness of 2 mm reduces the MOR value. The use of PVC edges with a thickness of 2 mm also reduces the MOE value. It was found that the use of the tested edges significantly reduces the swelling and water absorption of the elements after 2 hours of soaking in water. A significant reduction in swelling after 24 hours of soaking in water occurs when using 2 mm PVC, 1 and 2 mm ABS edges. On the other hand, a significant reduction

in water absorption after 24 hours of soaking in water was found when using PVC and ABS edges with a thickness of 2 mm. Edging made of PVC and ABS with a thickness of 1 mm was also noted to have the best adhesion to narrow surfaces of particleboard when using EVA hot melt adhesive.

Streszczenie

W ramach badań wąskie powierzchnie listew z płyty wiórowej trójwarstwowej laminowanej o gęstości 600 kg/m^3 i grubości 18 mm oklejono materiałami obrzeżowymi. Wykorzystano do tego celu obrzeże PVC o grubości 1 i 2 mm, obrzeże ABS o grubości 1 i 2 mm, obrzeże z papieru impregnowanego mieszanką żywic mocznikowo-formaldehydowych UF i melaminowo-formaldehydowych MF, laminat, forniry z orzecha amerykańskiego o grubości 2 mm nielakierowane (surowe) i lakierowane. Dodatkowo przygotowano wariant kontrolny bez obrzeży. Obrzeża zostały przyklejone do płyty wiórowej za pomocą kleju topliwego EVA. Dla przygotowanych próbek zbadano wybrane właściwości mechaniczne (MOR, MOE, wytrzymałość na odrywanie obrzeży) i fizyczne (spęcznienie i nasiąkliwość po 2 i 24 h moczenia w wodzie).

Na podstawie przeprowadzonych badań stwierdzono, że stosowanie obrzeży wykonanych z PVC i ABS o grubości 2 mm wpływa na obniżenie wartości MOR. Stosowanie obrzeży PVC o grubości 2 mm wpływa również na obniżenie wartości MOE. Stwierdzono, że stosowanie badanych obrzeży znacznie ogranicza spęcznienie oraz nasiąkliwość elementów po 2 godzinach moczenia w wodzie. Znaczne ograniczenie spęcznienie po 24 godzinach moczenia w wodzie następuje przy zastosowaniu obrzeży PVC 2 mm, ABS 1 i 2 mm. Natomiast znaczne ograniczenie nasiąkliwości po 24 godzinach moczenia w wodzie stwierdzono przy zastosowaniu obrzeży PVC i ABS o grubości 2 mm. Odnotowano również, że obrzeża wykonane z PVC i ABS o grubości 1 mm odznaczają się najlepszą przyczepnością do wąskich powierzchni płyty wiórowej przy zastosowaniu kleju topliwego EVA.

Keywords: particleboard, edging, side surface finish, MOR, MOE, edge peel strength, thickness swelling, water absorption

Słowa kluczowe: płyta wiórowa, obrzeża, wykończenie wąskich powierzchni, MOR, MOE, wytrzymałość na odrywanie obrzeży, spęcznienie na grubość, nasiąkliwość

Introduction

During processing into finished products, furniture particleboard require protection of the side surfaces. This is required especially in places where they will be visible or exposed to destructive factors (e.g. moisture). The material commonly used for this purpose is the so-called edging tapes - products of various widths and thicknesses glued to the side surfaces of the boards with the use of hot melt and contact adhesives (traditional solutions) or

glueless with the use of a laser (new technologies). As in the case of surface finishes of wide surfaces, the edges fulfill two basic functions (Tyszka 1975, Proszyk 1999):

1. protect the side surfaces of the panels against the destructive action of external factors,
2. they give the products appropriate aesthetic values.

Depending on the demand, the edges can be produced in thicknesses from 0.4 to 2.0 mm based on various materials, such as (Sözen 2008):

- natural or modified veneer,
- paper impregnated with a mixture of urea-formaldehyde UF and melamine-formaldehyde MF resins,
- polypropylene PP,
- polymethylmethacrylate PMMA,
- polyvinyl chloride PVC,
- poly(acrylonitrile butadiene styrene) ABS.

The selection of the right type of edging is dictated by the requirements that take into account aesthetic, technological and economic aspects. Miškinytė and Juknelevičius (2022) found, among other things, that oak edge bands have better adhesion to particleboard compared to ABS edge bands. However, the authors also indicated that ABS edgebands better protect furniture elements against moisture. In turn, Karaman (2022), examining the ability to keep wooden wheels in a chipboard covered with PVC edges with a thickness of 0.8, 1.0 and 2.0 mm, found that higher strength parameters are obtained with thinner edges. Tankut and Tankut (2010) indicated that the type and thickness of the edge used affect the strength of angle joints in furniture elements. In their research, the authors used edge bands made of PVC, paper impregnated with a mixture of UF and MF resins and natural veneer. The authors obtained the best strength parameters when the side surface of the element was covered with a paper tape.

In general, it should be noted that on an industrial scale, edgings made of PVC or ABS are most often used. The larger share of PVC in the edge banding market is currently only due to its lower price. It is worth noting that, for ecological reasons, ABS edges are becoming more and more popular. In general, it can be stated that ABS plastic has similar properties to hard PVC (Seachtling 2000, Jabłoński et al. 2009). It should be noted, however, that the properties of both materials can be modified during their production by introducing appropriate additives. Both in the case of ABS and PVC edges, they can be glued to the side surfaces of the boards using all types of edge banding machines. The main difference in the processing of ABS and PVC edges is the need for separate storage of waste from the latter polymer. While ABS waste can be incinerated with wood waste, PVC waste, due to the content of chlorine compounds, can only be processed by specialized companies. PVC material recycling is not a problem per se, but thermal utilization of this polymer in uncontrolled conditions leads to the formation of hydrochloric acid, dioxins and furans (Sadat-Shojai and Bakhshandeh 2011). These compounds are extremely toxic to humans and the environment. The issues of thermal waste disposal are particularly

important when it is impossible to separate PVC waste from other raw materials or when it is necessary to dispose of old products finished with this material. In this regard, ABS plastic is safe for both humans and the environment.

Edging bands are an important component of furniture elements both in terms of the conditions of their use, strength of connections and their impact on the environment. It is worth noting here, however, that the available literature lacks information on the impact of the use of edges on the strength of the furniture elements themselves, especially of small width - slats.

Aim and Scope

The aim of the work was to determine the effect of the type and thickness of the edge band used for gluing three-layer laminated particleboard on selected properties of furniture slats made of it.

The scope of work included the preparation of slats of three-layer laminated particleboard covered with various edge bands (ABS, PVC, laminate, paper impregnated with UF and MF resins, unvarnished and varnished veneer). For the prepared elements, the MOR, MOE, thickness swelling and water absorption after 2 and 24 hours of soaking in water and the peel off strength of the edge layer were tested.

Materials and research methodology

Three-layer laminated particleboard with a thickness of 18 mm and an average density of 600 kg/m^3 was used to manufacture the slats. Eight variants of edging tapes were used to cover the slats:

- variant A - PVC edging band with a thickness of 1 mm (Polkemic sp. z o.o., Poland),
- variant B - PVC edging band with a thickness of 2 mm (Polkemic sp. z o.o., Poland),
- variant C - ABS edging band with a thickness of 1 mm (Polkemic sp. z o.o., Poland),
- variant D - ABS edging band with a thickness of 2 mm (Polkemic sp. z o.o., Poland),
- variant E - laminate,
- variant F - paper impregnated with a mixture of UF and MF resins with a layer of polyacetate adhesive applied (Pfleiderer Grajewo S.A., Poland),
- variant G - raw American walnut veneer, 2 mm thick,
- variant H - American walnut veneer, 2 mm thick, finished with polyurethane varnish.

Slats with unfinished side surfaces (without edge bands) were used as the control variant 0. A HEBROCK EURO 2000 edge banding machine was used to cover the narrow surfaces of the slats. The edges, apart from the paper impregnated with a mixture of UF and MF resins with its own binder, were glued with Dorus Ks 611 hot melt adhesive (Henkel AG & Co. KGaA, Germany). After gluing, the slats were seasoned for a week in air at 20°C and 65% humidity. The width of the slats after double-sided gluing was 50 mm (including the thickness of the edges). The slats in the control variant, not edged, were also 50 mm wide.

For the manufactured slats, the following were marked:

- MOR i MOE according to PN-EN 310:1994,
- edge peel strength according to PN-EN 311:2004 standard - the test samples had dimensions of 50×20×18 mm^3, punches with a diameter of 20 mm were used during the test,
- thickness swelling after 2 and 24 hours of soaking in water in accordance with PN-EN 317:1999 - the test specimens were edged on four sides in accordance with the tested variant, the dimensions of the specimens after gluing were 50×50 mm^2,
- absorbability after 2 and 24 hours of soaking in water based on the guidelines of PN-EN 317:1999 (the same samples were used as in the case of the swelling test).

Ten samples were used for each test. The statistical analysis of the obtained results was carried out in the Statistica 13.1 program. The T-Student test was used to determine the significance of differences between the obtained results.

Results and discussion

Particleboard slats covered with edge bands on both sides, depending on the type of edge, were characterized by comparable or lower strength parameters in relation to slats with unfinished side surfaces (Figs 1-2). In the case of MOR, statistically significantly lower strength values were recorded in the case of slats covered with 2 mm PVC and 1 mm and 2 mm ABS edges (Fig. 1). The decrease in strength parameters in this case was 24%, 9%, 15%, respectively. Similarly, in the case of MOE, statistically significantly lower values of strength were recorded in the case of slats covered with PVC 1 mm and 2 mm, ABS 1 mm and 2 mm and paper edging (Fig. 2). The decrease in strength parameters in this case was 8%, 28%, 17%, 21% and 13%, respectively.

The decrease in MOR and MOE strength results from the limitation of the cross-section of the strips in relation to the strip of unglued chipboard (in the case of PVC and ABS 2 mm, it is 4 mm less in width). PVC and ABS edges are more susceptible to deformation than particleboard and other edge materials used (e.g. veneer). Higher susceptibility to deformation of PVC edge bands in relation to paper or natural veneer edges was also demonstrated in the tests of angle joints Tankut and Tankut (2010).

Considering the possibility of using individual edging bands to cover particleboards slats, it should be stated that they were generally characterized by similar peel strength (Fig. 3). The lowest peel strength was obtained for ABS 2 mm, PVC 2 mm and laminate edges. Similar relationships for ABS and oak veneer edges were obtained by Miškinytė and Juknelevičius (2022). However, they found that thinner edging bands had less adhesion to the panel surface. In this study, an inverse relationship was obtained - thinner edges were characterized by higher adhesion. It should be noted, however, that the adhesion of the edges in both cases was tested using different methods, which could have affected the final result.

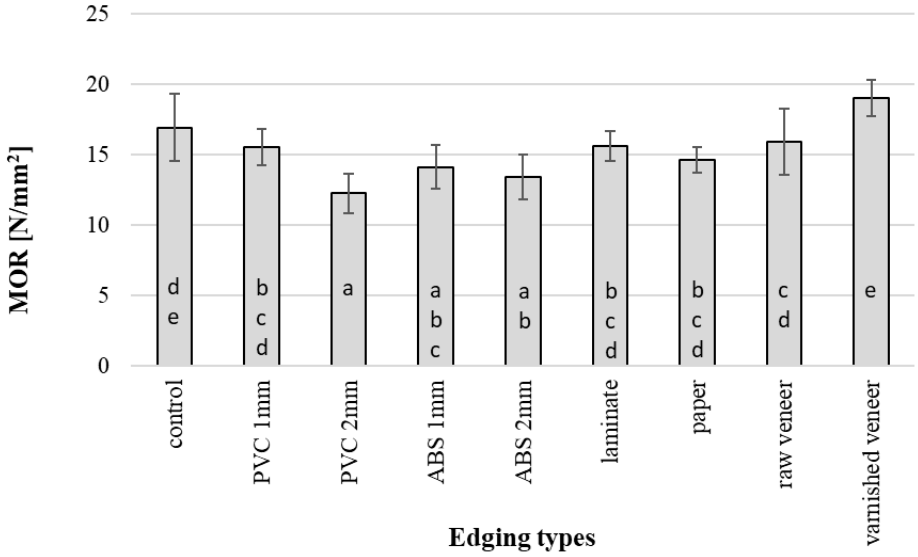

Fig. 1. MOR values of the tested boards finished with edges (a, b, c, d, e - homogeneous groups by Tukey test; I - standard deviation)
Rys. 1. Wartości MOR badanych płyt wykończonych obrzeżami (a, b, c, d, e - grupy jednorodne w oparciu o test Tukeya; I - odchylenie standardowe)

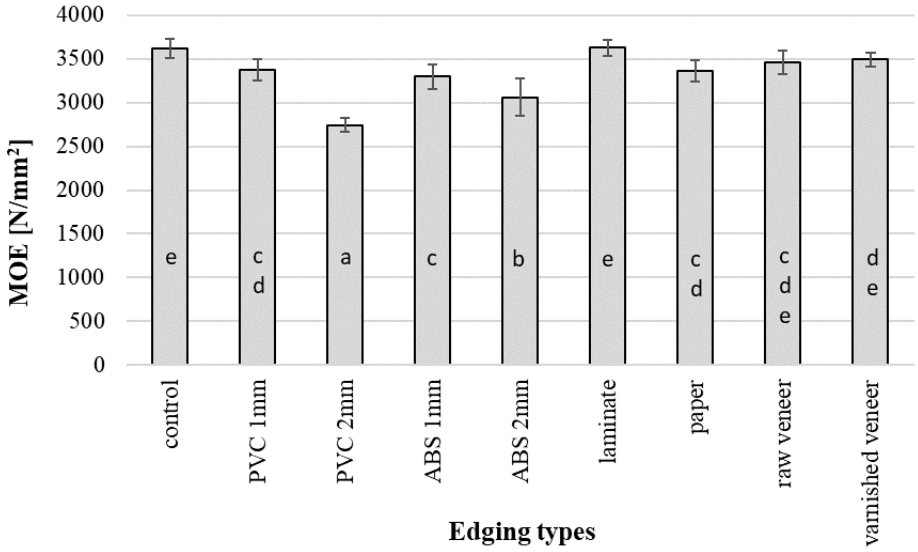

Fig. 2. MOE values of the tested boards finished with edges (a, b, c, d, e - homogeneous groups by Tukey test; I - standard deviation)
Rys. 2. Wartości MOE badanych płyt wykończonych obrzeżami (a, b, c, d, e - grupy jednorodne w oparciu o test Tukeya; I - odchylenie standardowe)

The use of edging bands is particularly beneficial in terms of the resistance of glued elements to moisture. Table 1 presents the results of the thickness swelling and water absorption tests of samples of slats finished with individual edges. It can be stated that all the types of edges used contributed to reducing the value of thickness swelling after 24 hours of soaking in water by at least 30% compared to samples without edging bands. It should be added, however, that PVC and ABS edging, especially with a thickness of 2 mm, allowed to reduce the thickness swelling and water absorption of the slats by approx. 70%. It is also worth pointing out that the 2 mm PVC and 1 mm and 2 mm ABS edges made it possible to obtain, on average, half the thickness swelling and water absorption of the skirting boards compared to elements covered with veneer, paper or laminate. Similar relationships with regard to ABS and veneer edges were obtained by Miškinytė and Juknelevičius (2022).

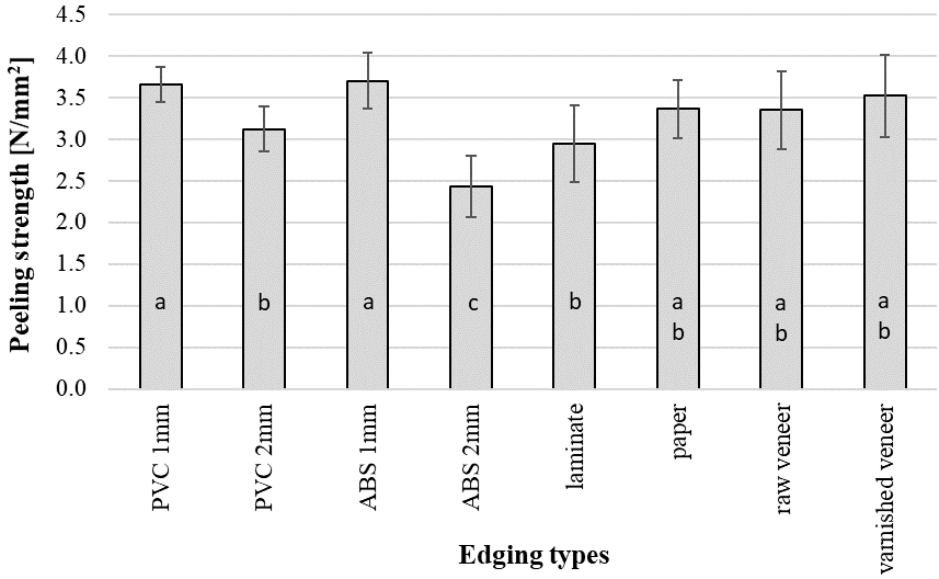

Fig. 3. Peeling strength values of edges (a, b, c - homogeneous groups by Tukey test; I - standard deviation)
Rys. 3. Wartości wytrzymałości na odrywanie obrzeży (a, b, c - grupy jednorodne w oparciu o test Tukeya; I - odchylenie standardowe)

Table 1. Values of swelling and water absorption of the tested slats
Tabela 1. Wartości spęcznienia i nasiąkliwości badanych listew

Type of edge band	Thickness swelling				Water absorption			
	2 h		24 h		2 h		24 h	
	Aver.	SD	Aver.	SD	Aver.	SD	Aver.	SD
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
control	5	1	20	2	22	4	66	6
PVC 1 mm	0	0	12	2	3	1	34	5
PVC 2 mm	0	0	5	1	2	1	20	5
ABS 1 mm	0	0	7	2	2	0	30	6
ABS 2 mm	0	0	6	2	2	1	22	4
laminate	0	0	13	2	3	1	43	7
paper	0	0	13	4	5	2	43	9
raw veneer	0	0	12	2	6	1	43	5
varnished veneer	0	0	14	3	4	3	59	12

aver. - average, SD - standard deviation

Conclusions

On the basis of the conducted tests of slats made of particleboard covered with 1 and 2 mm thick PVC edges, 1 and 2 mm thick ABS edges, laminate, edge made of paper impregnated with a mixture of UF and MF resins and edges made of raw and varnished veneers, the following conclusions can be drawn:

- The use of PVC and ABS edges with a thickness of 2 mm statistically significantly reduces the MOR and MOE values of the boards finished with edge gluing.
- The use of veneer edging does not change the MOR and MOE values of slats with finished edges.
- Edges made of PVC and ABS with a thickness of 1 mm are characterized by the best adhesion to side surfaces of particleboards when using hot melt adhesive.
- The use of the tested edges to cover narrow surfaces of particleboard slats significantly protects them against thickness swelling and water absorption after 2 hours of soaking in water (swelling value below 1%, and water absorption below 6%).
- The use of 2 mm PVC and 2 mm ABS edging significantly reduces thickness swelling and water absorption of particleboards slats after 24 hours of soaking in water.

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List of standards

PN-EN 310:1994 Płyty drewnopochodne - Oznaczanie modułu sprężystości przy zginaniu i wytrzymałości na zginanie

PN-EN 317:1999 Płyty wiórowe i płyty pilśniowe - Oznaczanie spęcznienia na grubość po moczeniu w wodzie

PN-EN 311:2004 Płyty drewnopochodne - Wytrzymałość na odrywanie warstwy przypowierzchniowej - Metoda badania

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