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THE DETERMINATION OF ADHESION STRENGTH OF WOOD VENEER AND SYNTHETIC RESIN PANEL (LAMINATE) ADHESIVES

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ABSTRACT

Wood veneer and laminates are stuck on various surfaces of wood-based boards by using different adhesives. Veneer must always be stuck to the surface to be veneered very well. However, such failures as structural differences among the equipments and adhesives used, irregular adhesion because of the errors in pressing and the errors of the users, wavings, swelling etc. arise in adhesion. The aim of this study is to determine the adhesion strength of Scots pine (*Pinus sylvestris* L.), Sessile oak (*Quercus petraea* L.), Eastern beech (*Fagus orientalis* L.) wood veneer and synthetic resin panel (laminate) on 18 mm particle board, medium density fiberboard (MDF) and ply-wood material in different amounts (100, 150, 200 g.m^{-2}) which were stuck with Polyvinyl acetate (PVAc), Urea-formaldehyde (UF) and contact (rubber based) adhesives. The adhesion strength of samples has been determined in accordance with the Turkish Standard (TS) 5339. According to research results, while the highest adhesion strength was observed on laminate on which adhesive was applied with 200 g.m^{-2} PVAc adhesive on ply-wood, the lowest adhesion strength was observed on particle board which was stuck with 200 g.m-2 contact adhesive on Eastern beech veneer.

KEY WORDS: particleboard, medium density fibreboard (MDF), plywood, veneer, laminate, wood adhesives, adhesion

INTRODUCTION

In general, wood-based boards (particleboard, plywood, MDF etc.) would have no avail in furniture and decoration industries on their own, neither are they suitable for qualified furniture production. In order for wood-based boards to be used in furniture production as indoor fittings, the surfaces of boards and the sides of boards should be veneered with various veneers. Wooden or synthetic resin panel (laminate) veneers are preferred in veneering the boards which are used in the production of furniture, wainscot, and ceiling cover due to various reasons such as enhancing the physical and mechanical features of boards, achieving a decorative outlook, improving the aesthetical value of the product, providing the natural outlook and warmth of wood, providing harmony between colors and patterns, preventing formaldehyde emissions (Budakci 2008, Kilic 2006, Güller 2001).

Wood veneer and laminates are stuck on various surfaces of wood-based boards by using different adhesives. Veneer must always be stuck to the surface to be veneered very well (Selbo 1975, Vick 1999). However, such failures as structural differences among the equipments and adhesives used, irregular adhesion because of the errors in pressing and the errors of the users, wavings, swelling etc. arise in adhesion.

Considering the literature in this field; radial and tangent section veneers made of pine, beech, and oak were stuck on the surfaces of particleboard, MDF, oriented strand board (OSB) with polyvinyl acetate (PVAc), UF, and contact adhesives, and it was stated that the highest adhesion strength was acquired with radial section beech veneer which was stuck on oriented strand board with urea formaldehyde, and the lowest adhesion strength was acquired with tangent section beech veneer which was stuck on the medium density fiberboard with contact adhesive (Kilic 2006). It was stated that while sticking wooden material with adhesives, adhesion depends on many factors such as wet-ability qualities of surface, penetration, reaction, polymerization, porosity, pH, moisture gradient, extractive materials, chemical interactions, free surface energy, surface area, and (radial section, tangent section, and cross section) surface of wood which will be in contact with the adhesive (Rowell 1995, Mahlberg 1998, Winfiel el al. 2001). As PVAc adhesive enables adhesion by forming an elastic film layer on the surface, and as it dispels the external forces or internal tensile forces that are applied to the whole adhesion surface equally, it has been stated that PVAc performs well against these forces (Altinok 1995, Skeist and Miron 1990, River 1994). According to the research on the technological features of three layered and okal type particle boards; it has been stated that the veneer stuck on the surface increased the strength features of the board in the experiments conducted to increase the strength features of the 16, 19 and 25 mm thick okal type particle boards, the surfaces of which are veneered with beech veneer (Göker et al. 1984). In the study in which the technological features of particle boards which were veneered with different surface veneers were compared, it has been argued that the physical and mechanical features of the board get better depending on the technological features of oak veneer, applied on the surfaces of boards, and of the veneering material (Akkilinç 1998). It has been proposed that the tensile strength perpendicular to the surface be applied to measure the quality of the adhesive and adhesive application, and surfaces of boards should be veneered with veneering materials in order to improve the strength perpendicular to the surface (Özdemir 1996). It has been noted that the surfaces of wood are porous because of the features stemming from the structure and the machines used to process the wood, and the features of adhesion can be enhanced by broadening the area between the surface of the wood and the veneering material (Järvela et al. 1999). Beech veneers 0.5 thick were applied on the surfaces of particle boards and medium density fiberboards with urea formaldehyde adhesive, and they were exposed to bending strength. It has been noted that the beech veneer, which was applied on the surface, enhanced the strength features of the board (Altinok 1999). The test samples prepared with the woods from Scots pine, Eastern beech, and oak were subjected to a tensile test after they were stuck with PVAc adhesive, and the highest adhesion strength was observed with the beech, the oak and the pine respectively. Moreover, it was noted that the flatness of the part on which adhesive was applied and the adhesion process affect the adhesion strength (Altinok 1998a). The bending strength and the tensile strength of the surfaces of flake boards were analysed after they were treated with beech veneer, and at the end of the study, it was stated that the veneering material enhanced the bending strength features and the tensile strength features of the board (Altinok 1998b).

From this perspective, the aim of the study is to determine the adhesion strength of Scots pine (*Pinus sylvestris* L.), Sessile oak (*Quercus petraea* L.), Eastern beech (*Fagus orientalis* L.) wood veneer and synthetic resin panel (laminate) which were applied in different amounts (100, 150, 200 $g.m^{-2}$) of PVAc, Urea, UF and contact (rubber based) adhesives on the surfaces of 18 mm particleboard, MDF and okume ply-wood material.

MATERIAL AND METHODS

Carrier Surface

In this study, 1st class 18 mm thick particle board, MDF, and okume plywood were used as the carrier surfaces because of their common usage and common production in Turkey (TS 2129, 1975, TS EN 12369-1, 2005, TS EN 313-2, 2005).

Adhesives

During the preparations of the test samples,PVAc, UF, and contact adhesives (rubber based adhesives) were used. It was proposed that a thermoplastic adhesive should be used in accordance with the Turkish Standard TS 5339 while applying adhesive on the steel cylinders, which were used in the adhesion strength experiments, however, no result was obtained in the pretestings because of the failure of the adhesive. As a consequence, a double compound epoxy adhesive was used in the study.

Veneering

In the experiment, while veneering carrier surfaces, 0.6 mm thick Scots pine *(Pinus silvestris* L.*),* Eastern beech *(Fagus orientalis* L.*)*, oak *(Quercus petraea* L.*)* wood veneers, which are widely used in furniture and decoration industries in Turkey, and 0,9 mm thick laminate with a bright surface, which is also widely used in the sector, were preferred. As to the fibre directions of the wood veneering boards, radial fibres or tangent fibres were chosen randomly, instead of any discrimination.

Preparation of Test Samples

The wood veneer, laminate, and carrier surface materials, which were prepared as drafts, were made to wait in an air conditioning chamber under the conditions of 20±2 °C heat and 65±3 % relative humidity in accordance with the principles of TS 5339 until they reached a stabilized weight (TS 5339, 1987).

Then, the wood veneers and the laminate material were stuck on the carrier surfaces with different amounts of PVAc, UF, and contact adhesive in line with the suggestion of the producing company. The conditions under which the samples were stuck are given in the Tab. 1.

Tab. 1: The conditions, under which the samples were stuck

Adhesive type	Amount of adhesive applied (±10 $g.m^{-2}$)	Press pressure ($N.mm^{-2}$)	Press period	Press heat (^0C)
PVAc	100	0.8	24 hour	20
	150			
	200			
UF	100	0.8	4 minute	80
	150			
	200			
Contact	200	0.8	5 minute	20
	250			
	300			

The adhesive used was applied in a manner that it would not exceed the amount determined by ±10 $g.m^{-2}$, after it was weighed with an analytical balance which had the accuracy of 0.01. A glue-spreading cylinder was used to apply PVAc and UF, and the adhesives were applied only on the carrier surfaces. The contact adhesive was applied on the surfaces of both the carrier boards and the veneers by means of an adhesion comb with thin tines. Right after PVAc and UF were applied on the surface, they were pressed. On the other hand, the contact adhesive was pressed after it was left to dry for approximately 10 minutes, and then it was pressed (Bally 2005). All of the pressing processes were performed by means of hydraulic press.

The pressed drafts were fully dried by keeping them in a laboratory for three weeks which is not directly exposed to sunlight and in which air circulation is available. Then, the draft pieces were grouped, and designed as 120 x 120 ± 0.1 mm according to TS 5339 1987. Prepared were 1080 samples according to the experimental design of 4 x3 x 3x 3 x 10,4 types of veneer, 3 carrier surfaces, 3 types of adhesive, 3 different amounts of adhesive and 10 experimental designs for each of these variables. Prior to the test of adhesion strength, the surfaces of wood veneer were sandpapered with 80 grid (on Norton scale) and 100 grid sandpaper in order to have a smooth adhesion surface. The dust on the sandpapered surface was cleaned with a soft haired brush and with the vacuum technique before the test. Then the samples were made to wait again under the conditions of 20±2 °C and 65±3 % relative humidity until they reached a stable weight in order to eliminate the differences in humidity which occurred in the processes of adhesion and preparation.

The samples were made of stainless 316 L chrome nickel steel, and were stuck on the soffit of the test cylinder, which has a surface smoothness of 1.05 μm using 150 ± 10 $g.m^{-2}$ epoxy adhesive, and by means of a squeezing mould which has the feature of centring on the dead centres of the samples. During these processes, particular attention was given to the fact that the pressure applied was perpendicular to the surface of the board and 1.5 $kg.cm^{-2}$ pressure on average was applied. The samples were left in this mould to dry for 24 hours.

Adhesion Strength Test

Adhesion strength tests of the samples prepared according to TS 5339, 1987 were performed with the hydraulic "Bond Test" device, which has the accuracy of 0.1 kN (TS 5339, 1987, Bond test device 2006). The tensile force of the test device, which was placed on the sample, was increased with a constant speed of no more than 1 kgf, and particular attention was given to the fact that the test was held in 60 seconds (TS 5339, 1987).

The adhesion strength of the veneer was calculated by applying the following equations to the ultimate tensile stress, which was found through the tests.

$$\sigma y = \frac{P\ max}{A} \qquad (N.mm^{-2})$$

In this equation :

σy = The adhesion strength of the veneer $N.mm^{-2}$

P max = Ultimate tensile strength N

A = The domain of the tensile surface 1000 mm^2

Statistical Method

SPSS statistics package program was used for statistical evaluations, and in consequence of the multiple variance analysis "ANOVA" tests, the effects of the factors of carrier surface, type of veneer, type of adhesive, and the amount of adhesive on the adhesion strength and the interactions among these factors were defined. With the help of Duncan test and the LSD (Least Significant Difference), critique values comparisons were made, and what factors caused the variance was examined.

RESULTS AND DISCUSSION

The results of the multiple variance analysis (ANOVA) of the adhesion strength measurements of the wood veneer and laminate adhesives are given on the Tab.2.

Tab. 2: The results of the multiple variance analysis (ANOVA) of the adhesion strength

Factor	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Prob.
Carrier surface (A)	2	137.121	68.560	1334.4676	0.0000*
Veneer type (B)	3	15.899	5.300	103.1506	0.0000*
Interaction (AB)	6	0.999	0.167	3.2419	0.0000*
Adhesive type (C)	2	49.704	24.852	483.7227	0.0000*
Interaction (AC)	4	20.974	5.244	102.0602	0.0000*
Interaction (BC)	6	3.767	0.628	12.2192	0.0000*
Interaction (ABC)	12	3.016	0.251	4.8916	0.0002*
Amount of adhesive (D)	2	13.170	6.585	128.1751	0.0000*
Interaction (AD)	4	8.750	2.188	42.5800	0.0000*
Interaction (BD)	6	2.581	0.430	8.3734	0.0000*
Interaction (ABD)	12	3.714	0.310	6.0249	0.0000*
Interaction (CD)	4	12.213	3.053	59.4294	0.0000*
Interaction (ACD)	8	7.399	0.925	18.0008	0.0000*
Interaction (BCD)	12	9.574	0.798	15.5299	0.0000*
Interaction (ABCD)	24	9.432	0.393	7.6495	0.0000*
Error	972	49.938	0.051		
Total	1079	348.252			

*: significant at 95 % confidence level

According to the results of the variance analysis, the carrier surface, the type of veneer, the type of adhesive, the amount of adhesive, and the interactions among these factors were significant to the adhesion strength of the veneers, stuck on the carrier surfaces with different amounts of different adhesives ($\alpha = 0{,}05$). The results of the Duncan test comparisons conducted on carrier surface level by using the LSD critique value are given on Tab. 3 and the graphic of these results is given on Fig. 1 respectively.

Tab.3: The results of Duncan test comparisons; Carrier surface N.mm^{-2}

Particleboard		Medium density fibreboard		Plywood	
$\bar{x}$	*HG*	$\bar{x}$	*HG*	$\bar{x}$	*HG*
1.143	B	1.903	A*	1.895	A
LSD ± 0.03303					

*: The highest adhesion strength value $\bar{x}$: Average value HG: Homogeneous Group

According to the Tab. 3, MDF and plywood have the highest adhesion strength, while particleboard has the lowest adhesion strength. It is also indicated in literature that MDF shows a better adhesion strength than particleboard (Kilic 2006, Altinok 1998a). The fact that MDF and ply-wood have high mechanical and technical features like massive wood material, and they are free from defects like knottiness, rottenness, brokenness of fibre, warping, cracking etc. (Küreli 1996, Özen 1975), which can be seen on massive wood material, can be explained as a quality that increases the adhesion strength.

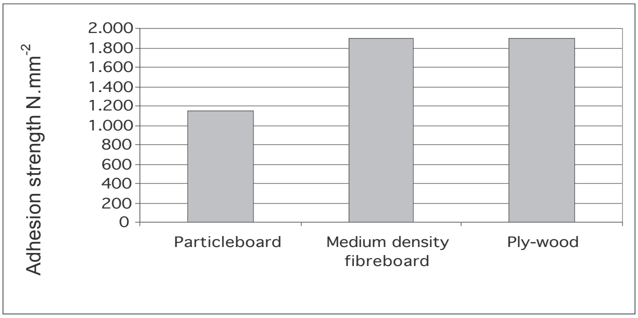


Fig. 1: The results of carrier surface comparisons

The low adhesion strength of particleboard is thought to result from its cohesion strength's being less than that of MDF's and plywood's. Considering the production procedure of particleboard, the fact that it is produced by sticking the particles of the other wood or lignified (lignocellulosic) botanical raw material with synthetic resin adhesives, and that the volume of internal space among particles is more than that of MDF and plywood, might have decreased the cohesion strength, and that is why the cohesion strength of particleboard might have been measured as lower than these materials. Furthermore, absorption of the adhesives by the porous surface of particleboard, and the deficiency in the amount of the adhesive in the intersection of the veneer and the surface of the particleboard can be considered as effective factors which caused the adhesion strength to be measured low. Additionally, the fact that the surface smoothnesses of MDF (2.9 μm) and ply-wood (2.6 μm) are more than that of particleboard (5.7 μm) in proportion might have increased the adhesion strength by increasing specific adhesion.

The comparison results of the Duncan test of the types of veneer are given on the Tab. 4, and the graphic of these results is given on Fig. 2 respectively.

Tab. 4: The results of Duncan test comparisons; Veneer type Nmm^{-2}

Scots pine		Eastern beech		Sessile oak		Laminate	
$\bar{x}$	*HG*	$\bar{x}$	*HG*	$\bar{x}$	*HG*	$\bar{x}$	*HG*
1.578	C	1.526	D	1.639	B	1.846	A*
LSD ± 0.03814							

*: The highest adhesion strength value $\bar{x}$: Average value   HG: Homogeneous Group

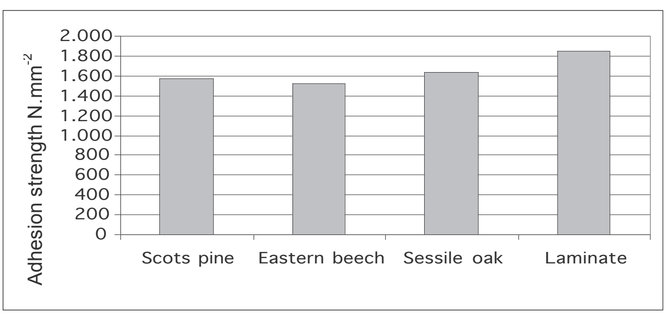


Fig. 2: The results of veener type comparisons

Accordingly, it was defined in the study that difference of veneer affects the adhesion strength. Among the types of veneer, laminate material has the highest adhesion strength, and Eastern beech has the lowest adhesion strength. It was determined that laminate material shows 11.2 % better adhesion strength than Sessile oak, 14.5 % better adhesion strength than Scots pine, and 17.3 % better adhesion strength than Eastern beech.

It is stated in the literature that when adequate pressure is applied in sticking the materials with smooth surface, equal adhesive is transferred from one surface to the other, and adhesion strength works best (Altinok 1999, Eckelman 1999). In this respect the fact that the space on the stuck surface of laminate material is less than the other three veneers, as a consequence of which there is enough adhesive on the stuck surface and specific adhesion increase, might have caused the laminate to show a better adhesion performance.

It is stated in the literature that the type and the thickness of the wood veneer material does not affect the tensile strength perpendicular to the surface of particleboard (Nemli 2000). However, it was found in the study that difference of veneer type affects adhesion strength.

The comparison results of the Duncan test of the types of adhesive are given on the Tab. 5, and the graphic of these results is given on Fig. 3 respectively.

Tab. 5: The results of Duncan test comparisons; Adhesive type N.mm^{-2}

UF		PVAc		Contact	
$\bar{x}$	*HG*	$\bar{x}$	*HG*	$\bar{x}$	*HG*
1.741	B	1.851	A*	1.351	C
LSD ± 0.03303					

*: The highest adhesion strength value $\bar{x}$: Average value   HG: Homogeneous Group

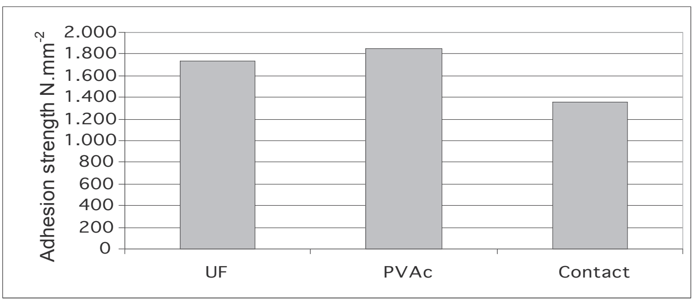


Fig. 3: The results of adhesive type comparisons

According to the table, PVAc has the highest adhesion strength, while contact adhesive has the lowest adhesion strength. PVAc shows 6 % better adhesion performance than UF, and 40 % better adhesion performance than contact adhesive. It is noted that while PVAc shows a high adhesion strength, as it enables adhesion by forming an elastic film layer on the surface and spreads the exterior and interior tension forces, which are applied to the join, to the whole stuck surface equally, it displays a high performance against these forces (Akltinok 1995, Skeist and Miron 1990, River 1994). Furthermore, it was stated in a different study that PVAc shows 0.12 % better adhesion performance than UF and 45.5 % better adhesion performance than contact adhesive (Kilic 2006). According to these results, the study is consistent with the literature.

The reason why contact adhesive shows lower adhesion strength than PVAc and UF is that because it has a high viscosity, it cannot penetrate into the pores of wood-based boards and veneers, and so it cannot provide enough mechanical and specific adhesion.

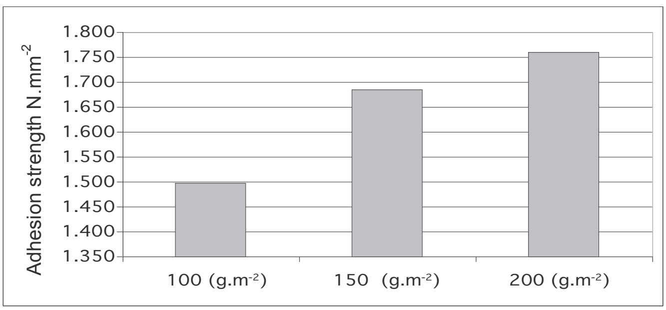
Because contact adhesive displays much lower adhesion strength than PVAc and UF, because it is not easily used to adhesive boards with broad surface, and because it resolves the adhesive layer after passing through the veneering pores of the solvent liquids in the varnish while varnishing the surfaces veneered with wood-based veneer, in the literature, it is not advised to use contact adhesive while sticking wood veneer on the surfaces of wood-based boards (Kilic 2006, Sanivar and Zorlu 1995, Sönmez 2000). It is noted that it can be used only to stick wood veneer on the surfaces of little boards which will be processed with upper layer materials which are curved, few in number and do not contain solvent (Selbo 1975, Sönmez 2000, Eckelman 1999).

The comparison results of the Duncan test of the amount of adhesive are given on the Tab. 6, and the graphic of these results is given on Fig. 4 respectively.

Tab. 6: The results of Duncan test comparisons; Amount of adhesive N.mm^{-2}

100 (g.m^{-2})		150 (g.m^{-2})		200 (g.m^{-2})	
$\bar{x}$	*HG*	$\bar{x}$	*HG*	$\bar{x}$	*HG*
1.497	C	1.686	B	1.759	A*
LSD ± 0.03303					

*: The highest adhesion strength value $\bar{x}$: Average value HG: Homogeneous Group



**Contact adhesive has been encoded as 200 g.m^{-2} =100 g.m^{-2}; 250 g.m^{-2} =150 g.m^{-2} ; 300 g.m^{-2}= 200 g.m^{-2} in order to keep the Table and the Figure in harmony statistically.

Fig. 4: The results of adhesive amount comparisons

Accordingly, the adhesion strength was determined in the application of 200 g adhesion strength per square meter at the most, and 100 g adhesion strength per square meter at the least. It was identified that 200 g.m^{-2} adhesive applied to the carrier surface shows 4 % better adhesion strength than 150 g.m^{-2} adhesive applied to the surface, and 15 % better adhesion strength than 100 g/m^2 adhesive applied to the surface. In the literature, it is stated that 120-200 g PVAc and UF per square meter should be applied to the wood material, and 250 g contact adhesive per square meter should be applied to the wood material (Sanivar and Zorlu 1995).

The comparison results of the Duncan test which was carried out to determine the interaction among the factors of carrier surface, type of veneer, type of adhesive, and amount of adhesive are given on the Tab. 7, and the graphic of these results is given on Fig. 5 respectively.

Tab. 7: The results of Duncan test comparisons; Carrier surface – Veener type – Adhesive type – Amount of adhesive N.mm⁻²

Factors ABCD*			UF			PVAc			Contact		
			100	150	200	100	150	200	200	250	300
Particleboard	Scots pine	$\bar{x}$	0.980	1.160	1.100	1.000	1.100	1.160	0.780	1.260	0.880
		HG	V-Z	Q-X	S-Z	V-Z	S-Z	Q-X	YZ	P-V	XYZ
	Eastern beech	$\bar{x}$	1.320	1.140	1.100	1.040	1.000	1.140	**0.720**	1.180	0.900
		HG	O-T	R-Y	S-Z	U-Z	V-Z	R-Y	**Z**	Q-X	W-Z
	Sessile oak	$\bar{x}$	0.920	1.180	1.140	1.320	1.140	1.140	0.740	1.300	1.060
		HG	W-Z	Q-X	R-Y	O-T	R-Y	R-Y	Z	O-U	T-Z
	Laminate	$\bar{x}$	1.660	1.760	1.440	1.320	1.260	1.260	0.860	1.240	1.460
		HG	I-O	G-N	M-S	O-T	P-V	P-V	XYZ	P-V	L-R
Medium density fibreboard	Scots pine	$\bar{x}$	1.940	2.020	1.800	2.120	2.020	1.940	1.480	1.580	1.880
		HG	E-J	D-H	F-M	CDEF	D-H	E-J	L-R	J-Q	F-K
	Eastern beech	$\bar{x}$	1.740	2.380	1.860	1.940	1.940	1.860	1.100	1.560	1.740
		HG	G-N	ABCD	F-K	E-J	E-J	F-K	S-Z	J-Q	G-N
	Sessile oak	$\bar{x}$	1.820	2.040	1.800	2.160	2.420	1.840	1.460	1.340	2.120
		HG	F-L	D-H	F-M	CDEF	ABCD	F-L	L-R	O-T	CDEF
	Laminate	$\bar{x}$	2.160	2.360	2.140	2.220	2.220	2.100	1.460	1.700	2.260
		HG	CDEF	ABCD	CDEF	BCDE	BCDE	C-G	L-R	H-O	BCDE
Ply-wood	Scots pine	$\bar{x}$	1.770	2.000	2.200	2.020	2.420	2.040	1.260	1.240	1.520
		HG	G-N	D-I	BCDE	D-H	ABCD	D-H	P-V	P-V	K-Q
	Eastern beech	$\bar{x}$	1.680	1.760	1.780	1.620	2.240	2.340	1.160	1.140	1.760
		HG	H-O	G-N	F-M	I-P	BCDE	ABCD	Q-X	R-Y	G-N
	Sessile oak	$\bar{x}$	1.420	1.800	2.580	2.580	2.560	2.520	0.920	1.400	1.540
		HG	M-S	F-M	ABC	ABC	ABC	ABC	W-Z	N-T	K-Q
	Laminate	$\bar{x}$	2.000	2.300	2.410	2.440	2.500	**2.840**	0.760	1.020	2.680
		HG	D-I	ABCD	ABCD	ABCD	ABC	**A***	YZ	U-Z	AB

*: The highest adhesion strength value $\bar{x}$: Average value HG: Homogeneous Group
**: A: Carrier surface, B: Veener type, C: Adhesive type, D: Amount of adhesive (g.m⁻²)

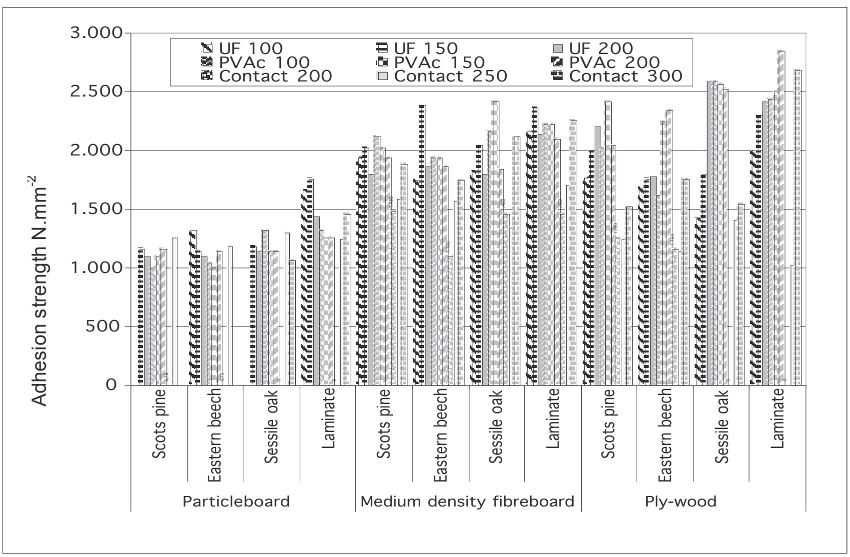


Fig. 5: The results of carrier surface – veener type – adhesive type – amount of adhesive (g.m⁻²) comparisons

Accordingly, the highest adhesion strength was observed with laminate which was stuck by applying 200 g PVAc adhesive per square meter on the surface of ply-wood, and the lowest adhesion strength was observed with beech veneer which was stuck by applying 200 g contact adhesive per square meter on the surface of particleboard.

CONCLUSION

According to the results of the study, it is determined that carrier surface, difference of adhesives, and amount of adhesive used affects the adhesion strength of Scots pine, Sessile oak, Eastern beech and laminate veneer.

Because adhesion strength of wood veneer and laminate to be stuck on the surfaces of wood-based board are different, while choosing types of veneer, the quality of furniture, the quality, features and surface outlook (pattern) of the place where the furniture will be used should be considered. For the surfaces which require high adhesion strength, laminate, oak, pine and beech are advisable respectively.

According to data acquired in the study, the difference between the adhesion strength of PVAc and the adhesion strength of UF is insignificant. Concordantly, instead of PVAc, UF can be preferred to stick wood and laminate veneer to the wood-based board because of many superior features such as its ease of use, drying quickly, having irreversible layer and reversible molecules and suitability for mass production.

According to the findings of the study, there is a slight difference of 4 % between the application of 200 g adhesive per square meter and the application of 150 g adhesive per square meter. That is why; the application of 150 g adhesive per square meter is thought to be better in terms of economising the usage of material.

According to these results, in the processes of sticking wood veneer or laminate which require high adhesion strength; sticking the veneers to the surfaces of MDF or plywood boards, not using contact adhesive if it is not necessary, preferring PVAc or UF adhesive, applying 150 g adhesive per square meter in order to avoid using unnecessary amounts of adhesive and economise, are advisable.

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