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DETERMINATION OF THE BONDING STRENGTH OF THE COATED WOODVENEER ON SOME WOOD BASED BOARDS

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Abstract

In this study, it is aimed to determine the wood veneer bonding strength on wood-based boards. Particleboard, fiberboard, and oriented strandboard have been chosen as a testing material due to their widespread usage. Radial and tangential cut veneers made of pine, beech, and oak have been glued on the surface of the boards with some adhesives such as polyvinyl acetate, ürea-formaldehyde, and contact glues. A total of 540 testing examples have been tested according to the conditions of determined in the TS 5339 standard. At the end of the tests, the highest bonding strength has been determined in the combination of radial-cut beech veneer, oriented strand- board, and ürea-formaldehyde glue as 2.21N/mm^2. The lowest bonding strength has been determined in the combination of tangential cut beech veneer, fiberboard, and contact glue as 0.77N/mm^2.

1. Introduction

The wood is a material precious and high quality, which has benefited people since the very first ages. In particular, developing industrial

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technology and modification of wood properties against weather conditions with nano-technological protectors all of them were significantly increased by using wood and wood-based products in the world [1].

Using of wood-based boards in industrial production, their surfaces and edges to be coated with various coating materials. Especially in the furniture production wood based boards are coated with natural wood sheet. Natural wood coated surfaces provide good physical and mechanical properties and decorative image to boards. It increases the aesthetic value of products, provides color-pattern relationships, and prevents formaldehyde emission.

Physical and mechanical properties of the plate coated with different wood veneer was found increased [2, 3].

Wood veneer has been used in the natural coating of the surface, especially in the construction of indoor furniture from wood species to be used is required. Coating process that provides the ease of industrial adhesives are preferred. Coating process (in pressing) will be used to determine the adhesive, sheet and coated sheet of its kind, which will be used in the known media [4].

Covering plate (tangential and radial intersection), and formed by the combination of types of glue, at least one of them because of the negative effects of heave plates on the surface coating has occurred. Puff, especially in the furniture industry is considered as an important quality disorder [5]. Coating adhesion to the surface of the sheet of puff generally low performance, applied to the surface of the protective coating of varnish to be higher in the case of surface tension is known to occur. And, adhesion to the coating process is done in several studies for the performance can be seen.

16mm, 19mm, and 25mm (vertical-chip) chip-seal coating of sheet strength, values kp/cm^2, respectively, 25,261kp/cm^2, 24,865kp/cm^2, and 19,874kp/cm^2, were determined as [6].

Plating parameters and application of the technical effects of boards have been investigated. Plating type and thickness, press temperature, press time and press pressure, and perpendicular to the surface of the drawing boards of the kind of glue to the effective strength, is not specified [7].

Furthermore, urea-formaldehyde glue using the 0.5mm thick beech covered with coatings and uncoated particleboard and medium density fiberboard in; uncoated particleboard in the bending strength 27.7N/mm^2, particleboard covered in bending strength 36.0N/mm^2, and uncoated fiberboard in bending strength 28.9N/mm^2, coated fiberboard in bending strength was determined as 36.1N/mm^2 [8].

Wood species, number of layers, and types of glue to the effect of bending strength, was investigated study PVAc glued with glue stick five-layer beech highest strength, the lowest in the oak was determined to be [9]. Also, it has been reported that the surface quality affects positively to the adhesion [10].

The intersection of wood bonding performance aspects have been investigated, have been identified that radial cross cut intersection surfaces best, tangential cross cut intersection surface medium, and diagonal (45o) cross cut intersection surfaces gave the worst results [11].

Oak, fir, beech, and pine were investigated in the adhesion properties, and it was determined that radial cross intersection showed 13.4% of adhesion performance better than tangents cross intersection [12].

The purpose of this study, the surface of different wood based boards (particleboard-YL, medium density fiberboards-MDF, and oriented strand board-OSB), different types of wood veneer (oak, pine, and beech), which were cut radial and tangential directions, as glue polyvinyl acetate-PVAc, urea-formaldehyde-UF, and contact-KT using the coating in case of boards-wood veneer type-intersection direction-glue combination of adhesion performance to identify and coatings swell of prevention is to contribute.

2. Materials and Methods

2.1. Materials

Wood-based board. In this study, widespread industrial use is based, 18mm thick particleboards for general purposes-YL (TS EN 312), medium-density fiberboard-MDF (TS 64-5 EN 622-5), and oriented strand board-OSB (TS EN 300) was used. Wood-based boards were obtained from dealers in Ankara board dealer.

Wood veneer. Wood-based boards to cover; radial and tangential finish-way intersection and 0.6mm thick, beech veneer (Fagus Orientalis L.), Scotch pine veneer (Pinus silvestris L.), and oak veneer (Quercus Petrea L.) were used. Coating sheet has been obtained from dealers in Ankara vendor.

Glue. Wood veneer to glue; polyvinyl acetate-PVAc (TS 3891), urea-formaldehyde glue-UF, and contacts-KT were used. In addition, metal testing apparatus to glue, Henkel branded in code Thomsit R-625 [13] was used polyurethane-based glue. Two-component polyurethane-based glue is realized as chemical bonding.

Preparation of testsample. In this study, coating adhesion tests for each plate type, glue type, coating type, and coating units 10 pieces to the cross direction $(3 \times 3 \times 3 \times 2 \times 10)$ total 540 pieces of experimental samples were prepared (Figure 1).

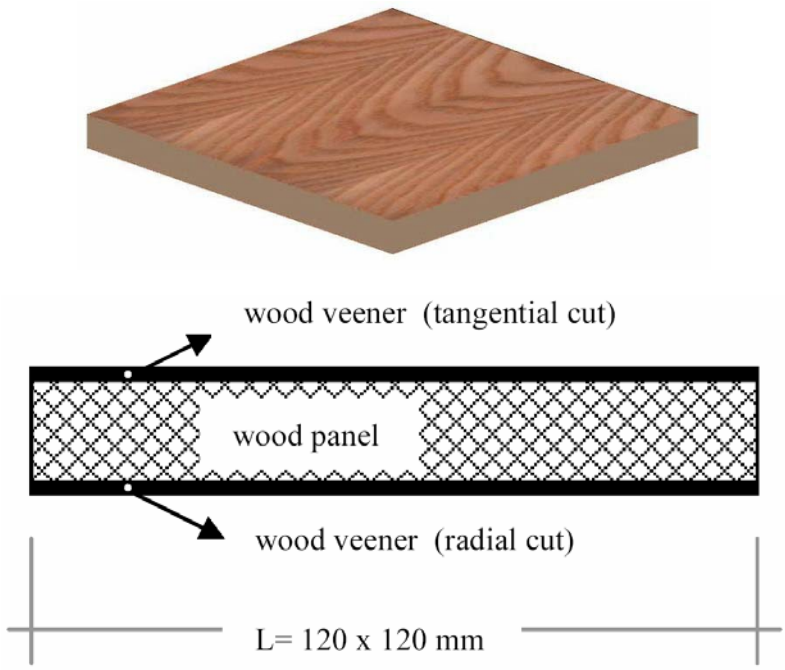

Figure 1. Testing sample (with radial and tangential wood veneer coated).

The value given in Table 1 in the gluing process has been complying with. Difference was related to duration of heat presses and presses due to the technical characteristics of glue. PVAc adhesive (thermo-plastic based) is a physical hardening adhesive: Press time 60min and temperature 20°C as applied press. UF adhesive (thermo-set-based) is a chemical-hardened resin adhesive: Press time 4min (short duration) and press temperature 80°C (high temperature) as applied press. KT adhesive is a solvent-based glue. Glue is applied to both surfaces. Wait until the glue is separated from the solvent solution (on hold). After the short-term is pressed by cold pres [14]. Pressing process was carried out in hydraulic press.

Table 1. Gluing conditions of test samples

Glue type	Viscosity* (Cp)	Glue quantity (gr/m^2)	Pressure (kg/cm^2)	Press time (min)	Press temperature (°C)
PVAc	160 - 200	160	8	60	20
UF	400 - 600	160	8	4	80
KT	Packin viscosity	160	8	2	20

Test samples of coated boards with a precision of 0.1mm in TS 5339 standard specified size $(120 \times 120mm)$ has been cut. Then, samples were grouped and 20°C ± 2°C temperature and 65% ± 5% relative humidity in the air conditioning cabinet waited until constant weight was reached.

Test samples of adhesion test preparation: Test samples in the middle, 35.7mm in diameter pulling apparatus (test cylinder) affixed. For their was used bonding polyurethane based (Thomsit R-625) adhesive. Adhering to all pull apparatus example, $0.15N/mm^2$ pressure applied to examples and for a period of 24 hours under pressure have been waited for.

Around of metal pulling apparatus was cut up to coating thickness (carrier plates to the surface) with cutting tools. This will ensure that only the capture device to break the pasted field is applied. Cut the circle area $1000mm^2$ mature (Figure 3).

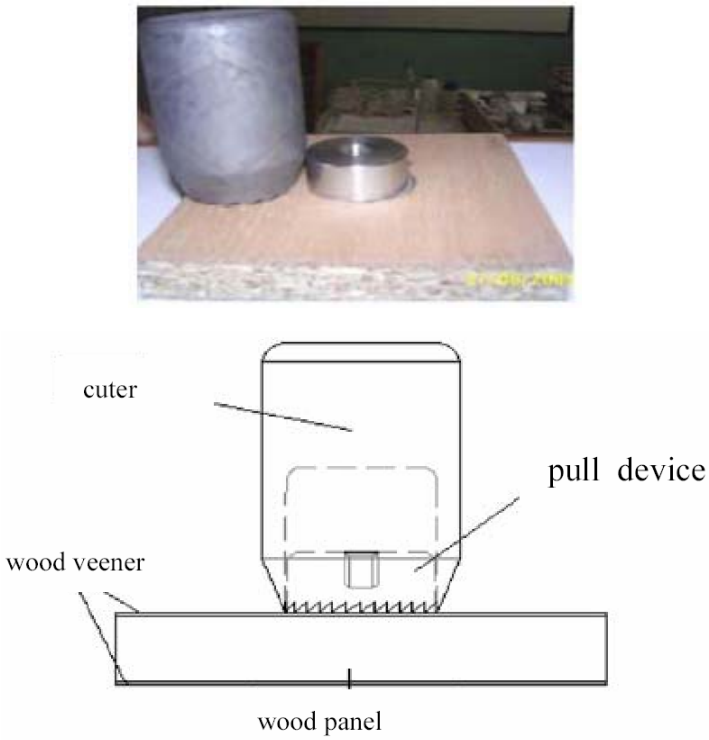

Figure 3. Drawing on examples pasted coating apparatus to be cut [15].

2.2. Experimental method

Adhesion performance of experiments were done in the Gazi University laboratory under power 688.1kgf in the device pneumatic adhesion (Figure 2).

Figure 4. Device for pneumatic adhesion [16].

Adhesion tests in the pull device pneumatic 1kgf 'like a constant speed can be increased, and within 60 seconds was carried out according to the principles of TS 5339. Veneer adhesion strength was calculated by applying tensile forces the following formula.

$$\sigma_y = \text{Veneer adhesion strength (N/mm}^2\text{)},$$

$$\sigma_y = \frac{P_{\max}}{A}\ \text{N/mm}^2, \qquad P_{\max} = \text{Tensile forces at (N)},$$

$$A = \text{Tensile surface area (1000mm}^2\text{)}.$$

2.3. Statistical methods

Statistical analysis to evaluate the coating adhesion strength has been made. For this purpose, the coating adhesion experiments, 3 board types, 3 veneer types, 3 glue types, and 2 veneer cut direction $3 \times 3 \times 3 \times 2$ factorial arrangement consisting 10 samples, and the data obtained from the multiple analysis of variance was applied $(\alpha = 0.05)$. Important of these factors occurs by applying the Duncan test for differences between groups were determined to be which.

3. Results

Veneer bonding results of the experiment are given the average values in Table 2.

Table 2. The average value of the strength of veneer bonding (N/mm²)

Board type	Glue type	Veneer type and cross direction					
		Radial cross-cut			Tangential cross-cut		
		beech	oak	pine	beech	oak	pine
YL	PVAc	1.56	1.29	1.42	1.23	1.45	1.11
	UF	1.38	1.38	1.31	1.27	1.38	1.10
	KT	1.29	1.19	1.24	0.87	1.31	1.33
MDF	PVAc	1.88	1.82	1.69	**1.84**	**1.80**	**2.13**
	UF	1.73	**1.95**	**1.78**	1.80	1.77	1.84
	KT	1.10	1.17	1.48	1.77	0.88	1.29
OSB	PVAc	1.91	1.76	1.28	1.73	1.59	1.51
	UF	**2.21**	1.76	1.51	1.41	1.67	1.72
	KT	1.04	0.93	0.91	1.10	0.95	1.10

Determine the effects to veneer bonding strength, given in Table 2 values of board type, glue type, veneer type, and veneer cross-cut directions were applied analysis of multiple variance. Important factors are irrelevant and meaningless the results are given in Table 3.

Table 3. Multi-variance analysis of the results.

Source of variance	DF.	Sum of square	Mean square	F-value	$P < 0.05$ significant
A (board type)	2	8.757	4.378	104.4737	0.0000
B (glue type)	2	30.379	15.189	362.4398	0.0000
A × B	4	9.232	2.308	55.0731	0.0000
C (veneer type)	2	0.042	0.021	0.5001	NS
A × C	4	2.799	0.700	16.6989	0.0000
B × C	4	2.527	0.632	15.0770	0.0000
A × B × C	8	0.503	0.063	1.4992	0.1548 *
D (Cross-cut direction)	1	0.772	0.772	18.4272	0.0000
A × D	2	0.089	0.044	1.0564	0.3485 *
B × D	2	0.188	0.094	2.2479	0.1067 *
A × B × D	4	1.840	0.460	10.9764	0.0000
C × D	2	1.944	0.972	23.1889	0.0000
A × C × D	4	1.797	0.449	10.7225	0.0000
B × C × D	4	0.014	0.004	0.0845	NS
A × B × C × D	8	2.353	0.294	7.0174	0.0000
Hata error	486	20.367	0.042	-	-
Toplam total	539	83.603	-	-	-

NS: meaningless

Board type (LSD: ± 0.04244): At the level of board type, the highest bonding strength was obtained in MDF 1.595N/mm^2 as. During this, it was followed in OSB as 1.449N/mm^2 and in YL as 1.284N/mm^2.

Glue type (LSD: ± 0.04244): At the level of glue type, the highest bonding strength was obtained in PVAc as 1.611N/mm^2. During this, it was followed in UF as 1.609N/mm^2 and in KT as 1.107N/mm^2. Statistical difference between the UF and PVAc glue was insignificant.

Board type + glue type binary interaction (LSD: ± 0.07350): At the level of board type + glue type, the highest bonding strength was obtained in MDF with PVAc glued as 1.860N/mm^2.

During this, it was followed in MDF with UF glued as 1.812N/mm^2, in OSB with UF glued as 1.714N/mm^2, in OSB with PVAc glued as 1.630N/mm^2, in YL with PVAc glued 1.345N/mm^2, in YL with UF glued as 1.302N/mm^2, in YL with KT glued as 1.204N/mm^2, in MDF with KT glued as 1114N/mm^2. The lowest bond strength was obtained in OSB with KT glued as 1.004N/mm^2.

Board type + veneer type of binary interaction (LSD: ± 0.07350): At the level of board type + veneer type, the highest veneer bonding strength was obtained in MDF pine-coated as 1.701N/mm^2. During this, it was followed in OSB beech-coated as 1.567N/mm^2, in MDF oak-coated as 1.565N/mm^2, in MDF beech-coated as 1.520N/mm^2, in OSB oak-coated as 1.441N/mm^2, in OSB pine-coated as 1.340N/mm^2, in YL oak-coated 1.333N/mm^2, in YL beech-coated as 1.267N/mm^2. The lowest bond strength was obtained in YL pine-coated as 1.251N/mm^2.

Veneer type + glue type binary interaction (LSD: ± 0.07350): At the level of veneer type + glue type, the highest veneer bonding strength was obtained in beech with PVAc glued as 1.693N/mm^2. During this, oak with UF glued as 1.651N/mm^2, beech with UF glued as 1.633N/mm^2, in oak with PVAc glued as 1.618N/mm^2, in pine with UF glued as 1.544N/mm^2, in pine with PVAc glued as 1.523N/mm^2, in pine with KT glued as 1.225N/mm^2, in oak KT glued as 1.070N/mm^2. The lowest bond strength was obtained in beech with KT glued as 1.027N/mm^2.

Cross-cut direction (LSD: ± 0.03465): At the level of cross-cut, the highest veneer bonding strength at radial intersection as 1.481N/mm^2, the lowest at tangent intersection as 1.405N/mm^2 was obtained. Radial and tangential intersection among themselves were compared. It has been identified that, it is showed 5.4% better veneer bonding strength at radial intersection than at tangential intersection.

Board type + glue type + cross-cut direction triple interaction: Board type, glue type, and cross-cut direction triple intersection effects of the veneer bonding strength differences between groups are given in Table 4.

Table 4. At the level of board type, glue type, and cross-cut direction triple intersection Duncan test comparison results (N/mm^2)

Board type	Glue type	Veneer cross-cut direction			
		Radial direction		Tangential direction	
		X	HG	**X**	HG
YL	PVAc	1.425	D	1.265	EF
	UF	1.354	DE	1.250	EF
	KT	1.239	EF	1.169	F
MDF	PVAc	1.797	B	**1.923**	A *
	UF	1.821	AB	1.802	B
	KT	1.250	EF	0.979	G
OSB	PVAc	1.652	C	1.607	C
	UF	**1.828**	A*	1.601	C
	KT	0.959	G	1.048	G
LSD: ± 0.1039					

Veneer type + cross-cut direction binary interaction (LSD: ± 0.06001): At the level of veneer type and cross-cut direction, the highest veneer bonding strength was obtained in radial way, the lowest was obtained in the tangential way beech finish. The difference at the junk came statistically significant between pine and oak veneer with tangents intersect.

Board type + veneer type + cross-cut direction triple interaction: Board type, veneer type, and cross-cut direction triple intersection effects of the veneer bonding strength differences between groups are given in Table 5.

Table 5. At the level of board type, veneer type, and cross-cut direction triple intersection Duncan test comparison results (N/mm²)

Board type	Veneer type	Veneer cross-cut direction			
		Radial direction		Tangential direction	
		X	HG	**X**	HG
YL	beech	1.413	DE	1.121	I
	pine	1.320	EFG	1.181	HI
	oak	1.285	FGH	1.381	DEF
MDF	beech	1.570	BC	1.470	CD
	pine	1.651	AB	**1.751**	A
	oak	1.647	AB	1.483	CD
OSB	beech	**1.721**	A	1.412	DE
	pine	1.235	GH	1.444	D
	oak	1.482	CD	1.400	DE
LSD: ± 0.1039					

Board type + glue type + veneer type + cross-cut direction four interaction (LSD: ± 0.1800): Board type, glue type, veneer type, and cross-cut direction four intersection effects of the veneer bonding strength differences between groups are given in Table 6.

Table 6. At the level of board type, glue type, veneer type, and cross-cut direction four intersection Duncan test comparison results (N/mm²)

Board type	Glue type	Veneer type	Veneer cross-cut direction			
			Tangential direction		Radial direction	
			X	HG	**X**	HG
YL	PVAc	beech	1.564	FGHI	1.228	NOPQR
		pine	1.416	IJKLMN	1.112	PQRS
		oak	1.294	JKLMNOPQ	1.454	IJKLM
	UF	beech	1.383	IJKLMNO	1.269	LMNOPQ
		pine	1.306	JKLMNOPQ	1.102	QRS
		oak	1.374	IJKLMNO	1.379	IJKLMNO
	KT	beech	1.291	KLMNOPQ	0.865	TU
		pine	1.239	MNOPQR	1.330	JKLMNOP
		oak	1.188	OPQR	1.311	JKLMNOPQ
MDF	PVAc	beech	1.879	BCD	1.844	BCD
		pine	1.690	DEFG	**2.129**	A
		oak	1.822	BCD	1.797	BCDE
	UF	beech	1.735	BCDEF	1.795	BCDE
		pine	1.782	BCDE	1.837	BCD
		oak	1.946	B	1.775	BCDEF
	KT	beech	1.097	QRS	0.772	U
		pine	1.480	HIJKL	1.288	KLMNOPQ
		oak	1.172	OPQR	0.876	TU
OSB	PVAc	beech	1.912	BC	1.730	BCDEF
		pine	1.285	LMNOPQ	1.506	GHIJK
		oak	1.759	BCDEF	1.585	EFGHI
	UF	beech	**2.210**	A *	1.409	IJKLMN
		pine	1.511	GHIJ	1.724	CDEF
		oak	1.762	BCDEF	1.670	DEFGH
	KT	beech	1.041	RST	1.097	QRS
		pine	0.910	STU	1.103	QRS
		oak	0.926	STU	0.945	STU
LSD: ± 0.1800						

4. Conclusion

The radial and tangential intersection with beech, pine, oak were covered to YL, MDF, and OSB surfaces with PVAc, UF, and KT glue. The following results were obtained veneer bonding strength tests of this natural experiments.

It was obtained highest veneer bonding strength in terms of board type in MDF as 1.595N/mm^2, second in OSB as 1.449N/mm^2, and lowest in YL as 1.284N/mm^2. Accordingly, it has occurred better bonding in the MDF 10% compared to OSB, and while 24.2% compared to YL. It has been reported that surface quality affects to bonding positive in the Reference [5]. Then, the other two boards of MDF perform better bonding, the surface quality of the board better than the other boards from the fact it can be said. Results are consistent with the literature. MDF can be recommended as a priority, which surface coating quality is important in the production of furniture and decoration elements.

It was obtained highest veneer bonding strength in terms of glue type with PVAc as 1.611N/mm^2, the second with UF as 1.609N/mm^2, the lowest with KT as 1.107N/mm^2. PVAc was showed better bonding performance 0.12% compared to UF, and while 45.5% compared to KT. This is because the solution of PVAc and UF penetration and plate surface adhesion bond to establish a broader, KT glue solution to the plate and less on the surface can not penetrate due to the adhesion bonds can be said to establish. It was seen that the difference between PVAc and UF is very low. PVAc to cold pressing, because of hardening in a short time and suitability for mass production of the many superior features, such as boards due to surface vessels UF glue can be recommended as a priority. TK glue may be appropriate coating for shaped surface and small plates.

It was observed during the test that break is not usually carried out at the adhesion joints (bonding line) within the wood-based board. Therefore, the veneer bonding strength in terms of species came to be statistically insignificant. Type and thickness of wood veneer is not taking effective perpendicular to the surface of the particleboard is expressed as

number 7 in the literature. Therefore, it can be recommended as appropriate to the veneers will be covered with wood-based boards on the nature of the furniture, use to the characteristics of interest.

It was obtained the highest veneer bonding strength in terms of cross-cut direction with radial intersection as 1.481N/mm^2, and the lowest in the tangential intersection as 1.405N/mm^2. Veneers with radial intersection were showed better bonding performance 5.4% compared to veneers with tangential intersection. It was showed radial intersection a better bonding performance 13.4% compared to the tangential intersection is expressed as number 12 in the literature. This is because the intersection with radial surfaces, such as a strip extending self rays is, intersect with the tangential surfaces are located in the small oval holes and spaces are the effect. Results are consistent with the literature number 11.

Board type and variety of adhesive bonding strength in the bilateral interaction, the highest in MDF with PVAc glued as 1.860N/mm^2, the lowest in OSB with KT glued as 1.004N/mm^2 was obtained. Using PVAc in MDF is better 85.2% than KT in OSB was shown.

Board type and veneer type binary interaction, the highest adhesive bonding strength was obtained in the MDF with pine coated as 1.701N/mm^2, the lowest in the YL with pine coated as 1.251N/mm^2. According to the pine-coated MDF, the bonding strength has been realized lower than beech and oak-coated MDF and OSB approximately 10%-12, YL 30%. Here, effectly factor is common effects of the roughness of veneer texture (especially oak) and surface quality.

Glue type and veneer type in bilateral interaction, the highest adhesive bonding strength was obtained in beech with PVAc glued as 1.693N/mm^2, the lowest in beech with KT glued as 1.027N/mm^2 was obtained. Veneer types are same in the both boards (beech). It was observed to be just as the different glue types and 64.8% rate of adhesive bonding strength between them. According to the beech veneer with PVAc glued, the adhesive bonding strength has been realized lower than the approximately 3-4% in beech and oak veneer with UF glued and 10% in pine. Here important factor is the structure and viscosity of glue said to be.

Board type, glue type, and cross-cut direction three interaction, the highest adhesive bonding strength was obtained in combination of tangential-cut veneer coated MDF with PVAc as 1.923N/mm^2, the lowest in combination of radial-cut veneer coated OSB with KT as 0.959N/mm^2. Adhesive bonding strength ratio between them is higher than 100%. It is said that factors here to be surface quality in the veneer and board (MDF-radial-cut), glue structure, and viscosity. Results are consistent with the literature number 11.

Veneer type and cross-cut direction bilateral interaction, the highest adhesive bonding strength was obtained in the radial-cut beech as 1.568N/mm^2, the lowest in the tangential-cut beech as 1.334 N/mm^2. The radial-cut of the beech compared to 17.5% higher adhesion bonding strength than tangential-cut of the beech was seen. Results are consistent with the literature number 12.

Board type, veneer type, and cross-cut direction three interaction, the highest adhesive bonding strength was obtained in the tangential-cut pine coated MDF as 1.751N/mm^2, the lowest in the tangential-cut beech coated YL as 1.121N/mm^2. It was observed that the rate of adhesive bonding strength is 56.1% between them. In the triple interactions with oak veneer, especially, rays on the surface of radial-cut oak (deep groove shape) and resin canals (filled with extractive substances) can be said to *adversely affect adhesion* (Table 5).

Board type, glue type, veneer type, and cross-cut direction four interaction, the highest adhesive bonding strength was obtained in the radial-cut beech coated OSB with UF as 2.210N/mm^2 and the lowest in the tangential-cut beech coated MDF with KT as 0.772N/mm^2. OSB is also the reason why the highest, production from the leaves chips, radial-cut beech has the surface smooth and homogeneous, the UF glue to the better penetration within the OSB whether the adhesion bonds can be establish. Adhesion strength between the lowest and the highest is 286% of the ratio (about three-time) was seen (Table 6).

All combinations according to the highest adhesion strength (2.210N/mm²), the % ratio is also given in Table 7.

Table 7. Amount of percentage compensation of all combinations according to the highest bond strength values (%)

Board type	Glue type	Veneer type	Cross-cut direction	Bonding strength (N/mm²)	Percentage compensation (%)
YL	PVAc	Beech	Radial	1.564	0.71
	UF	Beech	Radial	1.383	0.63
	KT	Beech	Radial	1.291	0.58
MDF	PVAc	Pine	Tangential	2.129	0.96
	UF	Oak	Radial	1.946	0.88
	KT	Pine	Radial	1.480	0.67
OSB	PVAc	Beech	Radial	1.912	0.87
	UF	Beech	Radial	2.210	**1. 00**
	KT	Pine	Tangential	1.103	0.51

As a result, using the research material, consider to manufacturers and designers given in Table 7 % of the ratio can be recommended.

References

[1] M. Altinok, Sandalye Tasarýmýnda Gerilme Analizine Göre Mukavemet Elemanlarinin Boyutlandirilmasý, Doktora Tezi, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara, (1995), 1-33.

[2] R. Özen, Yonga Levha Endüstrisi Ders Notlan, Karadeniz Teknik Üniversitesi Orman Fakültesi, Trabzon, Giriş, (1980), 1-2.

[3] H. Akkilinç, Farkli Yüzey Malzemeleriyle Kaplanmiş Yonga Levhalarda Teknolojik Özelliklerin Araştirilmasi, Yüksek Lisans Tezi, Istanbul Üniversitesi Fen Bilimleri Enstitüsü, Istanbul, (1998), 1-11, 53-56.

[4] Y. Örs, Kama Dişli Birleşmeli Masif Ağaç Malzemede Mekanik Özellikler, Yardimci Ders Kitabi, Karadeniz Teknik Üniversitesi Orman Fakültesi, Trabzon, (1987), 1-38.

[5] T. Özdemir, Mutfak Mobilyasi Üretiminde Kullanýlan Yüzey Kaplama Malzemelerinin Yonga Levha Kalitesi Üzerine Etkileri, Yüksek Mühendislik Tezi Karadeniz Teknik Üniversitesi Fen Bilimleri Enstitüsü, Trabzon, (1996), 89-90.

[6] Y. Göker, R. Kantay, A. ve Kurtoğlu, Üç Tabakalý ve Okal Tipi Yonga Levhalarýn Teknolojik Özellikleri Üzerine Araştirmalar, Istanbul Üniversitesi Orman Fakültesi, Istanbul, (1983), 111-112.

[7] G. Nemli, Yüzey Kaplama Malzemeleri ve Uygulama Parametrelerinin Yonga Levha Teknik Özellikleri Üzerine Etkileri, Yüksek Lisans Tezi, Karadeniz Teknik Üniversitesi Fen Bilimleri Enstitüsü, Trabzon 3 (2000), 138-139.

[8] M. Altinok, Yonga ve Lif Levhalarda Ahşap Kaplama ile Kama Dişli ve Çitali Boy Birleştirmelerin Eğilme direncine etkileri, Gazi Üniversitesi Teknik Eğitim Fakültesi Politeknik Dergisi 2(4) (1999), 65-71.

[9] N. Döngel, Lamine Ahşap Malzemede Ağa9 Tür, Katman Sayisi ve Tutkal Çeşidinin Eğilme Direncine Etkileri", Yüksek Lisans Tezi, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara, (1999), 25-26.

[10] M. Altinok, Ağaç işleri Temel Makinelerinde işlenmiş Ahşap Yüzeylerin Yapişma Direncine Etkileri, Gazi Üniversitesi Teknik Eğitim Fakültesi Politeknik Dergisi 1(2) (1998), 17-20.

[11] C. M. Bircan, Bazi Ağaç Türlerinde Kesiş Yönlerinin Farkli Tutkallar ile Elemansiz Yapişma Performanslarinin Belirlenmesi, Yüksek Lisans Tezi, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara 31 (2000).

[12] D. Ö. Balkiz, Agaç işleri Endüstrisinde Kullanilan Önemli Bazi Yerli Ağaç Türleri Odunlarinin Yapişma Özelliklerini Tespiti Üzerine Araştirmalar, Yüksek Lisans Tezi, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara, (2000), 121-124.

[13] Thomsit Flooring Systems-Henkel Roctite Adhesives Limited, Winford, Cheshire, CW7 3QY.

[14] M. L. Selbo, Adhesive bonding of wood, Dept. Agr. Technical Bulletin, No: 1512, Washington 61 (1975), 1-3.

[15] I. Kiliç, Bazi Ahşap Esasli Levhalarda Kaplama Yapişma Direncinin Belirlenmesi, Yüksek Lisans Tezi, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara, (2006).

[16] M. Budakçi, Pnömatik Adezyon Deney Cihazi Tasarimi, Üretimi ve Ahşap Verniklerinde Denenmesi, Doktora Tezi, Gazi Üniversitesi Fen Bilimleri Enstitüsü, Ankara, 60 (2003).

* TS EN 312, Yonga Levhalar-Özellikler, T.S.E., Ankara, (2005), 1-17.

* TS EN 300, Oriented Strand Board (OSB)-Definitions; Classification and Specification, T.S.E., Ankara, (1997), 1-12.

* TS 64-5 EN 622-5, Lif Levhalar Özellikler-Kuru Iþlem Levhalarýnýn (MDF) Özellikleri, T.S.E., Ankara, (1999), 1-20.

* TS 5339, Kaplama Yapişma Mukavemetinin Tayini, T.S.E, Ankara, (1987), 1-7.

* TS 3891, Yapiştiricilar-Polivinil asetat Esasli Emülsiyon, T.S.E, Ankara, (1987), 1-12.

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