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DETERMINATION OF CORNER JOINT PERFORMANCE ON THE MELAMINE-FACED FIBERBOARD (MDF-LAM) CONSTRUCTION

Mustafa ALTINOK*, Ayhan ÖZÇİFÇİ, H. Hüseyin TAŞ*****

* Technical Education Faculty, Gazi University, 06580 Beşevler-Ankara

**Technical Education Faculty, Karabuk University, 78050 Karabuk

***Engineering and Architecture Faculty, Süleyman Demirel University, 32100 Isparta

Abstract

The strength of the joints in panel construction manufacturing has a direct effect on life cycles of this kind of products. The factors affecting the strength are the board selected in the phase of manufacturing and the adhesive which enables the rigidity of the joint surface. The purpose of this study is to investigate the effects of diagonal forces (diagonal compression and tension) on different types of adhesives used for the joints of panel construction manufacturing which joined fiberboard (MDF-Lam) covered with melamine plaque by mixed joining method (dowel + lath-joint). For this reason, different types of adhesives were used (PVAc, Polymarine and Silicon) for preparing MDF-Lam samples. Only the samples which had adhesive variables were administered diagonal compression and tension tests. As a result, resistance to diagonal compression and tension were determined higher in Silicon-adhered samples than other samples.

Key Words: Fiberboard covered with melamine plaque, joint, Performance

1. Introduction

The industrial technology affecting furniture manufacturing sector, has led to important innovations in this sector. New wood-based panels, wood adhesives solidifying fast and having high- resistance, composite joint elements and variable accessories are listed as a number of those innovations. However, the effects of adhesive as a new variable in the sector for corner joint performance are not completely determined in wood based panel constructions which are different in terms of their structural features and aesthetic. For this reason, randomly selected panels, joint method which is not appropriate for the panel's structural features and new adhesives cause various manufacturing defects. Although there are some research studies in this field, innovations and developments require more ARGE facilities.

Mechanical features and design of wood-based panels in standard sizes have been analyzed by several researchers like many materials commonly used in furnishing and construction sectors [1]. It has been reported that in glued corner joints of box furniture constructions, the highest resistance is obtained in dowel joint and the weakest resistance is gained in lamp joint.
[2]. As a result of the resistance analysis of test samples prepared by particle board for corner joints, it is stated that dowel corner joint type has the best result while foreign ledge corner joint type takes the second place [3]. They also indicated that PVAc (Polivilinasetat) adhesive has got the highest resistance level in L type corner joints [4]. It is reported that "Moltinject" type of joint has higher resistance values compared to dowel joint in particle board box furniture constructions [5].

It is stated that the strength of compression and tension is the highest when the distance between two dowels is 7.5cm for dowel joint in particle board construction [6]. In particle board samples prepared with PVAc adhesive, the highest flexural resistance has been obtained respectively in lamp joint, barbed wire- lamp joint and cotter - lamp corner joints [7]. Researchers have stated that tension and compression resistance increase

Corresponded Author; altinok@gazi.edu.tr

when the size of dowels increases in particle board one dowel box construction corner joints [8]. It is also indicated that using 8 mm dowels rather than 10 mm, flat dowels in fiberboards, grooved dowels in particle boards for dowel joints in box furniture constructions is appropriate and the rise in dowel numbers increases tension resistance, decreases compression resistance.

The purpose of this study is to determine the resistance value differences during the interaction of different adhesives with hybrid joint type which is designed by considering widely used and traditional joint types in the constructions of fiberboard covered with melamine plate, to select the optimum glue for MDF-lam combined with hybrid joint method and to contribute to the prevention of losses in this sector.

2. Material and Method

2.1 Material

2.1.1 Fiberboard covered with melamine resin

In the experiments, phenol which is under 25 N/mm^2 compressions per unit with 170 ^{0}C temperature or wood-based panels covered with melamine sheets are used on 180x1830 x 3660 mm sized fiberboards that were manufactured with Urea-formaldehyde adhesives.

2.1.2 Adhesive

Ahşap ve ahşap esaslı levhalardan tasarlanan birleştirmelerin sağlamlığı için birleştirme metodunun yapısına The elements of joints are required to have sufficient dimensions changing according to the structure of joint methods for the stability of wood and wood-based panel assembly. Also, wood joints should be pasted with various adhesives to have sufficient rigidity. For this reason, PVAc, Polimarin and Silicone adhesives that are commonly preferred in furnishing sector are used on the test samples prepared with mixed joint method.

PVAc adhesive has a number of advantages during its application. It is nonflammable and odorless, does not damage cutters, solidifies fast and it is easily used while it is cold. However, there are some disadvantages of PVAc adhesive. It melts when the temperature increases so mechanical resistance declines and above 70 0C degree, PVAc adhesive does not join the components. 150-200 gr/cm ² adhesive is sufficient to use on one of the boards to be joined according to the type of joint materials and features of the surface. During the application of PVAc adhesive on test samples, principles defined in TS 3891 are considered. 1.1 gr/m ³ of density, 160-200 cps of viscosity and 5 ph value are optimal numbers for this type of adhesive. In the pressing process, 20 minutes for 20 0C , 2 minutes for 80 0C are sufficient for cold gluing and it is suggested to be left for resting on the pressing until it gets cold [10].

Desmodur-VTKA (Polimarin) adhesive is used to assemble wood materials that are not damaged by water and sea water under outdoor conditions. It causes the loss of sensitivity in case of touch on the skin and eyes due to its harmful chemical components. The recommendations of manufacturing company are taken into consideration to use the Polimarin adhesive. The surfaces for applying adhesive should be cleaned, dry, smooth and free from oil and dust. Upon the adhesive is applied to a surface, the elements should be joined at most in 30 minutes and it should be hold as pressed at least for 2 hours. Using gloves during the application of the adhesive and not joining the elements under 5 ^{0}C are recommended [11].

Purocal is a polyurethane-based and silicone looking adhesive. It has been recently used in furnishing sector. It is used to stick many construction materials such as fiberboard, formica, concrete, metal, plastic and especially wood materials which has 30 ^{0}C degree of moisture. It is a transparent adhesive which does not drip, gets into the joining spaces in a short time. It is resistant to water and chemicals and can be used between -30 ^{0}C and 100 ^{0}C. The recommendations of manufacturing company are taken into consideration to use the Purocal adhesive. The surfaces for using adhesive should be clean and free from oil. Sub-surfaces should be moisturized for the adhesive to fill in the joining spaces, gets into them and enhance the pace of joining. When it is used on one of the surfaces, it should be compressed with clamp for 30 minutes and left for drying. The optimal temperature to use the adhesive is between +5 ^{0}C and +35 ^{0}C. It should be kept in cold and dry places [12].

2.2 Method

2.2.1 Preparation of test samples

MDF-Lam, the measure of which is 18mmx183x366cm, has been processed in lies flat and milling machines and the parts for test samples have been prepared. The parts classified as A and B groups, have been united by using the specifications quantities and sizes in Table1 as in Figure 1.

Table 1. The properties of the prepared test sample, quantity and dimensions

Installation method and number		**Table size (mm)**		**The size of merge element**		**Adhesive Type**
				Dowel (mm)	**Foreing lath (mm)**	
< Pressure	**^ Tension**	**Leng**	**Width**	**L**	**L**	
10	10	320	200	Ø 33x10	120x18x7	PVA
10	10	320	200	Ø 33x10	120x18x7	Polymarine
10	10	320	200	Ø 33x10	120x18x7	Silicone

Preparation of mixed joint (with dowel and foreign lath) test samples

Marking process has been made for dowel and foreign lath on the surfaces and bays of MDF-Lam plate elements classified as A and B groups. 10 mm diameter, 17 +-1mm depth holes and 120x7 mm sized, 9+-1 mm depth niches have been opened on the surfaces of A group elements and bays of B group elements. PVAc adhesive has been used in the holes of A group elements, 33 x 10 +-1 mm sized dowel and 20 x 18 x 7 mm sized foreign lath have been inserted to their places. PVAc adhesive has been used for the bays of B group elements and joint points of these elements have been compressed and left for solidifying.

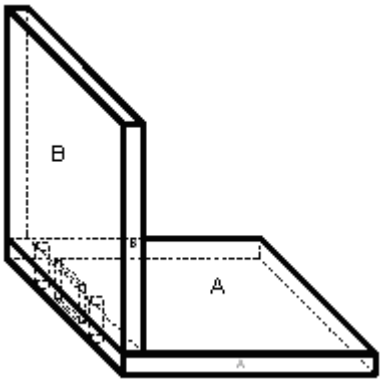


Figure1. Mixed joint test sample

2.3 Test Method

The factors which are effective to determine the strength of panel-furniture constructions are wood-based panels selected for case constructions, type of corner joint and the resistance of adhesive [13]. In case of mechanical strains occurring on corner joints of furniture, coercive forces try to close vertical and horizontal elements of furniture to each other in a corner while they try to open in the opposite corner (Figure 2). For this reason, diagonal compression and tension strain symbolizing closure and opening in casefurniture corners has been determined as the test method (Figure 3).

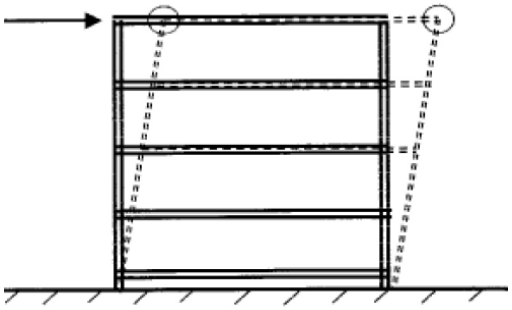
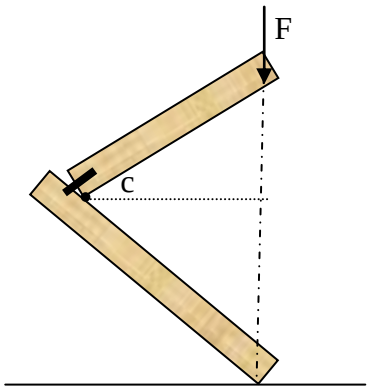
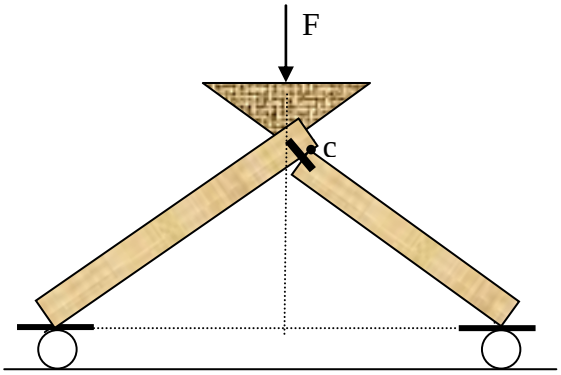


Figure 2. Strains in box corner joints



a.Diagonal compression



b) Diagonal tension

Figure 3.Diagonal compression and tension test

In the experiments, universal compression test device in the laboratory of Suleyman Demirel University, Technical Education Faculty, and Construction Education Department is used. Compression and tension tests have been carried out on samples when the indicator of the device was on 1000kg force level. During the test, force has been increased gradually and the maximum force (Fmax) at the time of the opening on joint and breaking points of the samples has been recorded as N type by benefiting from the computer monitor that the test device works with. These forces have been put on the formula below and their diagonal compression and tension resistance have been calculated.

The stress values that came out at the time of diagonal compression and tension have been determined by using the equality below which emerged from "external moment (Mex) = internal moment (Min)" principal. In this equality, adhesion stress safety of the adhesive is taken as constant value, 0.8 N/mm^2 on cross section surfaces. Adhesion conditions on dowel and foreign lath surfaces have been taken as the same.

From Here

Mex : Total external moment
Min : Total internal moment
F : Test force
L : Forces between the direction and the bearing point of the vertical distance
Nk : Number of Dowel
Nç : Number of foreign lath surface adhesion
Dk : Dowel diameter (mm)
Lk : Active length of dowel.
Lb : Foreign lath length.
Lt : Foreign lath depth
Lö : Test sample length.
Kö : Test sample thickness.
Lmk 1 : The vertical distance from the rotational axis of dowel
Lmç 2 : vertical distance of the foreign lath to turning point in the center of gravity to the surface
Lmö 3 : Turning point that cross-sectional surface perpendicular distance from the center of gravity
Ok Glue on the surface of the dowel sticking stress safety
Oç Glue on the surface of the foreign lath sticking stress safety
Oö Glue on the surface of the cross-section adhesion stress safety (Oçm = 0.8 N/mm^2)

2.4 Data Evaluation

The outcomes disrupting the normality distribution among the data obtained from diagonal compression and tension tests have been removed and the normality homogeneity is provided. When differences among groups have been determined as a result of statistical studies applied to the data, one Way ANOVA (simple analysis of variance) has been carried out to understand whether these differences are meaningful statistically or not.

3. Result and Discussion

Diagonal compression and tension resistance values, averages and standard deviation of mixed joint MDF-Lam boards according to various adhesive types are given in Table2.

Table 2. Diagonal compression and tension resistance values, averages and standard deviation of mixed joint MDF-Lam boards according to various adhesive types

Ahesive Type	**Diagonal pressure (N/mm^2)**		**Diagonal tension (N/mm^2)**	
	$\overline{X}$	**s**	$\overline{X}$	**s**
PVAc	7.69	1.085	33.20	2.74
Polymarine	7.18	0.77	22.65	3.08
Silicone	7.06	0.61	39.90	4.55

$\overline{X}$: Mean *s*: Standart Devision

Analyzing table 2, it is seen that average tension resistance values obtained from test samples of mixed joint with silicon adhesive is higher than the average resistance values of test samples of Polimarin and PVAc adhesive. PVAc adhesive has the highest diagonal compression value. The results of One Way ANOVA (simple analysis of variance) which has been carried out to understand whether these differences are meaningful statistically or not are given in table 3

Table 3. Variance analysis results for compression and tension values

Veriable	Compresion and tension value	Sum of squares	SD	Averages of Squares	F Value	p Value
Adhesive type	Pressure	223.800	2	111.900	1.561	0.228
	Tension	151251.66	2	75625.833	59.998	0.000*

* Statistically, meaningful at 5 % importance level

According to the variance analysis results, the difference between groups in terms of tension resistance for adhesive variety is meaningful at 5 % importance level. There is no meaningful difference in terms of compression resistance.

4. Conculusion

In this study, it has been determined that the type of adhesive changes the diagonal compression and tension resistance values on corner joints of MDF-Lam board which was assembled with mixed joint method.

At the end of the tests, considering the data obtained on adhesive variety level, silicone adhesive (39.90 N/mm^2), PVAc adhesive (33.20 N/mm^2) and Polimarin (22.65 N/mm^2) adhesive have respectively the highest average diagonal tension resistance values. It can be inferred that silicon adhesive's more and faster effect on the adhesion surface of dowel hole and foreign lath and its adhesion with stronger mechanical and specific joints are the reasons for silicone adhesives' having the highest diagonal tension resistance.

In box furniture constructions, both the diagonal compression and tension strain have occurred at the same time and silicone adhesive has got the highest adhesion resistance during both of the strains. For this reason, silicone adhesive are recommended as primary adhesive to use on case furniture manufactured with the method of mixed joint from MDF-Lam board. PVAc and Polimarin are respectively the second and third adhesives to be recommended for mixed joint box furniture made of MDF-Lam board.

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