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SCREW-HOLDING CAPACITY OF MELAMINE-FACED FIBERBOARD AND PARTICLEBOARD USED IN FURNITURE PRODUCTION

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Abstract

Solid wood and wood-based composite panels are used to produce different types of furniture. In the connection points of furniture, some different types of fasteners, such as screws, minifix, and dowels, are used to assemble the parts of the furniture. Melamine-faced fiber board (MF-FB) and melamine faced particle board (MF-PB) are used extensively in the production of furniture. In this study, we determined the screw withdrawal strength and screw head pull-through of MF-FB and MF-PB. Tests were conducted on the surfaces and edges according to ASTM D1037-12. The data that were obtained indicated that the screw holding capacity of MF-PB was greater than that of MF-FB. Also, the screw holding capacity was greater on the surfaces of both MF-PB and MF-FB than it was on the edges. In addition, screw head pull-through was greater than that of direct screw withdrawal in both MF-PB and MF-FB.
Keywords: Screw withdrawal, screw head pull-through fiber board, particleboard

MOBILYA ÜRETIMINDE KULLANILAN MELAMIN KAPLANMIŞ LIF LEVHA VE YONGA LEVHANIN VIDA TUTMA KAPASITESI

Özet

Masif odun ve odun esaslı kompozit levhalar farklı tiplerdeki mobilyaların üretimi için kullanılmaktadır. Mobilyanın bağlantı noktalarında, vida, minifiks ve kavela gibi bazı farklı tiplerde birleştirme elemanları mobilya parçalarını birleştirme için kullanılmaktadır. Melamin kaplanmış lif levha (MK-LL) ve melamin kaplanmış yonga levha (MK-YL) mobilya üretiminde büyük miktarda kullanılmaktadır. Bu çalışmada, MK-LL ve MK-YL'nın vida tutma direnci ve vida başı çıkma direnci belirlenmiştir. Testler levhaların yüzeylerinde ve kenarlarında, ASTM D1037-12 standardına göre yapılmıştır. Elde edilen veriler, MK-YL'nin vida tutma kapasitesinin MK-LL'ninkinden daha yüksek olduğunu göstermiştir. Bunun yanında, vida tutma kapasitesi yüzeylerde kenarlarda olduğundan daha yüksektir. Ayrıca, vida başı çıkma direnci hem MK-LL ve hem de MK-YL'de direk vida çıkma direncinden daha yüksekti.
Anahtar kelimeler: Vida çıkma, vida başı çıkma, lif levha, yonga levha

1 Introduction

Furniture has been important to people in their daily activities at home or in the workplace for thousands of years. In addition, some furniture serves as a component of the general decoration of houses, offices, gardens, and other public places. According to some researchers [1-4], there are many different ideas about the first furniture, and the ideas involve opinions concerning when and where the first furniture was made.

In some previous studies, there have been different ideas about what kinds of materials were used to produce the first furniture. For example; in previous studies, several literature sources have stated that the first furniture was made from wood in Egypt in ancient times [5-7]. In several other studies, it has been stated that the first furniture was made from stone in Skara Brae [8,9]. In some other studies, researchers stated that the first furniture was made from clay at a site in the Çatalhöyük in Konya City, Turkey [1-4].

Currently, according to usage areas, furniture parts are produced from different materials, such as solid wood, wood-based panels, plastics, glass, metals, and some composite materials. In general, there are two different methods for assembling the parts of furniture. Some furniture is already assembled, but other furniture is sold as ready-to-assemble furniture. The wood-based panels, such as particle board and fiber board, are used primarily for ready-to-assemble furniture. Screws, dowels, and adhesives are used in the production of assembled furniture. Dowels and minifixes are used to assemble the connection points. The stability of furniture depends on how well the connection points are assembled using fasteners.

The holding capacities of fasteners used to fasten wood-based composite boards, such as particle boards and fiber boards, have been investigated by some researchers [10-14]. These researchers investigated the relationships between some of the properties of wood-based panels and the screw-holding capacity. For example, Nemli and Kalaycıoğlu [11] studied the screw-holding capacity of melamin-faced and unfaced particle boards, and they concluded that coating with melamine impregnated papers improved the mechanical properties of the particle boards. Örs et al. [10] studied the holding strength of different types of screws for particle board, fiber board, werzalit, and beech wood in both parallel and perpendicular directions. Wang et al. [14] conducted experiments to determine the localized density effects on fasteners' holding capacities in oriented-strand boards, particle boards, and medium-density fiber boards. Vassiliou and Barboutis [13] studied screw withdrawal capacity used in the eccentric joints of cabinet furniture connectors in particleboard and fiber board. To the best of the author's knowledge, previous studies

have not conducted enough study to determine the screw head pull-through of MF-FB and MF-PB. Therefore, in this study, the direct screw withdrawal and screw head pull-through of MF-FB and MF-PB were investigated.

2 Material and Methods

In this study, MF-FB and MF-PB were obtained randomly from merchants in Kahramanmaraş City. The test samples were prepared from the boards. For each test group, 15 test samples were cut from boards. The dimensions of the test samples were 18 x 50 x 50 mm (thickness x width x length). The test samples were stored in a climatic chamber at 20 °C and 65% relative humidity. The direct screw withdrawal in the parallel (Fig. 1-A) and perpendicular directions (Fig. 1-B) were performed according to ASTM 1037-12 [15].

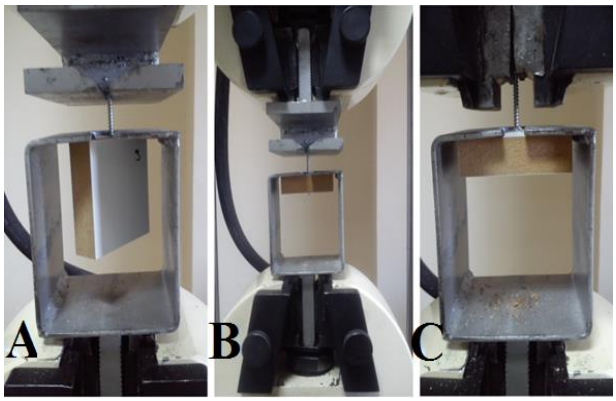

Fig. 1. Screw withdrawal: A) parallel; B); perpendicular; C) screw head pull-through

The screw head pull-through test (Fig. 1-C) also was performed according to this standard. The moisture content and density of the test samples were determined according to TS EN 322 [16] and TS EN 323 [17], respectively. Zinc screws were used in the screw tests. A pilot hole (3 mm) was drilled before the screw was inserted. The tests were conducted on Losenhausen test machines using the Robutest program. The data were evaluated using the SPSS statistical software program.

3 Results and Discussion

Table 1 provides data concerning the air-dried density, equilibrium moisture content, screw withdrawal in the perpendicular direction, screw withdrawal in the parallel direction, and screw head pull-through strength of MF-FB and MF-PB. In addition, Table 2 provides the results of the ANOVA tests of the boards and the surface factors for the screw withdrawal tests. An analysis of the data in Table 1, we found that the density values of MF-PB were greater than those of MF-FB. In addition, the moisture content of MF-PB is greater than that of MF-FB. Wood composite panels, such as fiber board, particle board, oriented-strand board, and plywood are produced in a hot press under pressure. The greater the pressure of the press is, the greater density of the panel will be. Particle size, tree species, adhesive and moisture content also affect density. Concerning this issue, many researchers have reported the same factors in previous studies [10, 11, 13].

The screw withdrawal strengths of both boards in the perpendicular direction were greater than in the parallel direction ($p < 0.001$), as can be seen in Table 3. The most important reason for this difference was the density profiles of the inner parts and the surfaces of the boards. The densities of both boards were greater at the surfaces and in the sub surfaces than the densities of the middle parts of the boards. For the screw withdrawal test, the screws were inserted into these three parts of the boards in the perpendicular direction. However, in the parallel tests, the screws were inserted only in the middle parts of the boards. The reason for this discrepancy was the density profiles of the boards. Similar results were reported by Örs et al. [10], Vassiliou and Barboutis [13], Wang et al. [14], and Nemli and Kalaycıoğlu [11]. In a previous study, it was reported that the reason for the discrepancy was the amount of adhesive in the middle parts of the PB [12]. In addition, there were some differences in the mechanical properties between the parallel and perpendicular directions in the fiber board, the particle board, and in the other solid wood and wood-based panels. For example, Bal and Bektaş [18] and Carvalho et al. [19] determined some differences between the flatwise and edgewise directions of laminated veneer lumber. Bal et al. [20] determined some differences in screw withdrawal strength between directions of solid wood lumber and laminated veneer lumber. Demirkır and Çolakoğlu [21] and Bal and Bektaş [22] determined some differences between the perpendicular and parallel directions of plywood. Another result of the tests was that the screw withdrawal of the PB was the greater than that of the FB ($p < 0.05$). In previous studies, dissimilar results were reported by Wang et al. [14], Vassiliou and Barboutis [13], and Örs et al., [12]. But, in their studies, the reason given for this unsuitability was the density of the MF-FB that they tested.

Table 1. Test results of MF-FB and MF-PB

	MF-FB					MF-PB				
	D	MC	SW-PR	SW-PL	SHPT	D	MC	SW-PR	SW-PL	SHPT
	g/cm³	%	N	N	N	g/cm³	%	N	N	N
x	0.590	8.4	1191	814	1724	0.619	10.4	1230	907	1963
ss	0.01	0.1	205	40	162	0.01	0.1	52	77	145
cov	1.9	1.6	17	5	9	1.6	1.2	4	9	7
max	0.609	8.8	1880	874	2035	0.631	10.6	1331	1026	2180
min	0.569	8.3	1022	745	1502	0.600	10.2	1143	702	1685

D: Density, MC: moisture content, x: arithmetic mean, ss: standard deviation SW-PR: screw withdrawal-perpendicular to surface, SW-PL: screw withdrawal-parallel to surface, SHPT: screw head pull-trough, N: Newton

Table 2. ANOVA test results of board and surface factors on screw withdrawal

Source	Type III Sum of Sq.	df	Mean Square	F	Sig.
Board	64616.017	1	64616.017	4.948	0.030
Surface	1833652.017	1	1833652.017	140.404	0.000
Board * Surface	11234.017	1	11234.017	0.860	0.358

Table 3.Tukey multiple comparison test result

Panel	n	SW
MF-FB	30	1002 a
MF-PB	30	1068 b
Surface	n	SW
Top surface	30	1210 a
Edge surface	30	860 b

Figs. 2A and 2B show the load-deformation curves of the screw withdrawal of MF-FB and MF-PB. Figs. 2C and 2D show the results of the screw head pull-through tests. Analysis of the curves in Fig. 2 clearly indicated that the amount of deformation of the screw head pull through at the end of the tests was greater than that of screw-withdrawal tests. In addition, the deformations at maximum load in the screw head pull-through tests were greater than those of the screw-withdrawal tests.

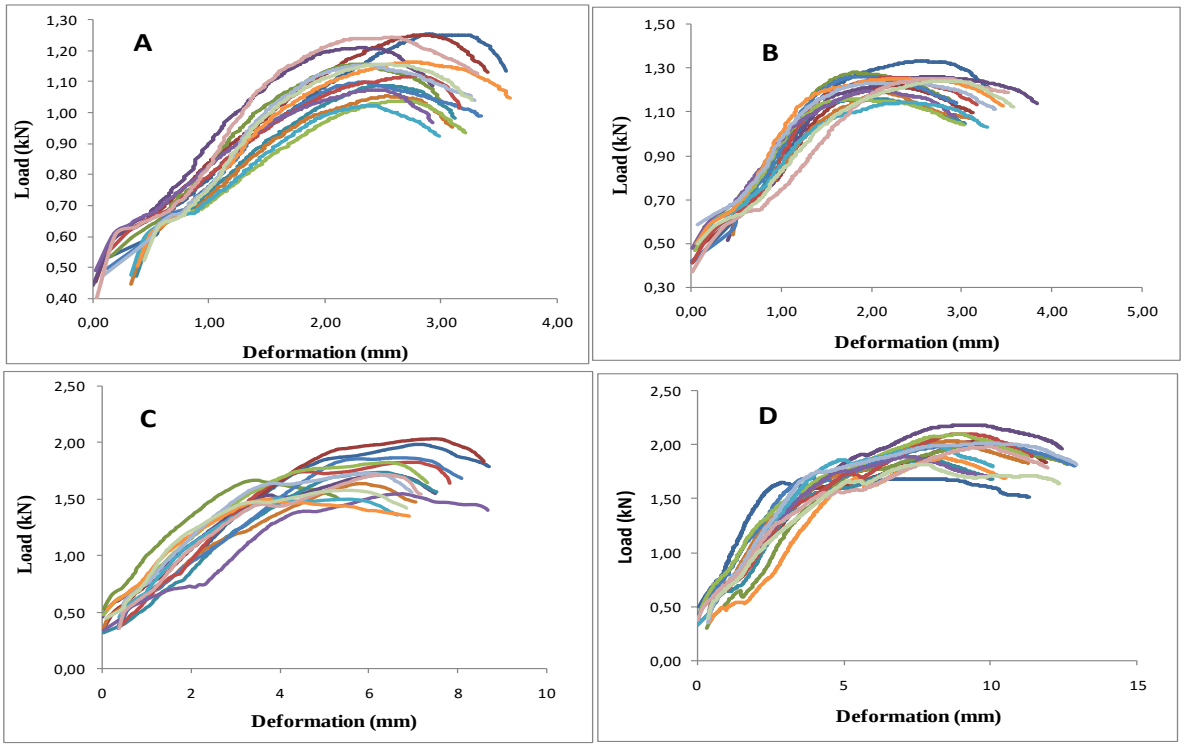

Fig 2. Load-deformation curves of the screw tests: A) Screw withdrawal of MF-FB; B) Screw withdrawal of MF-PB; C) Screw head pull through of MF-FB; D) Screw head pull through of MF-PB)

The deformations at maximum load in the screw withdrawal tests were between 2 and 3 mm for both MF-FB and MF-PB. But, the deformations at maximum load in the screw head pull-through tests for MF-FB and MF-PB were between 5 and 8 and 7 and 11 mm, respectively. In previous studies, similar curves were reported concerning the deformations at maximum load between the screw-withdrawal test and the screw head pull-through test by Bal and Efe [23].

4 Conclusions

In this study, we investigated screw-withdrawal strength and screw head pull-through strength of melamine-faced fiber board and melamine-faced particle board. According to the data that were obtained, following results can be inferred. The screw-holding capacity of melamine-faced particle board was greater than that of melamine-faced fiber board. The screw-holding capacity was greater on the surface than on the edges of both the melamine-faced fiber board and the melamine-faced particle board. In addition, screw head pull-through was greater than direct screw withdrawal in both then melamine-faced fiber board and the melamine-faced particle board. In addition, the deformation at maximum load in the screw head pull-through test was greater than that of the screw-withdrawal tests.

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