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THE EFFECTS OF PRESS TIME AND PRESS PRESSURE ON THE SCREW STRENGTH PROPERTIES OF ORIENTED STRAND BOARD (OSB) MANUFACTURED FROM SCOTS PINE

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Abstract:
In this study, the effects of press time and press pressure on the screw strength properties of oriented strand board was researched. For this purpose, 80mm long strands made of Scots pine (Pinus sylvestris L.) were bonded with phenol-formaldehyde resin at (9%) with three-layer cross-aligned OSBs. Strands used for the production of test panels were made up 50% of core layer and 50% of outer layers. The panels were pressed for four different press times, from 3, 5 to 9 minutes, under 2,94N/mm^2 and 4,90N/mm^2 press pressure, aiming for a target density of 670kg/m^3. It was showed that screw strength values were changed between 699-988N.

Key words: *Oriented strand board; Phenol-for maldehyde; Screw strength; Mechanical properties.*

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INTRODUCTION

Worldwide, economic growth and development have generated unprecedented needs for converted forest products such as pulp and paper, composite boars, plywood and lumber. Furthermore, the diminished supplies of larger dimension timbers have created high pricing (Grigoriu 2000). The wood composite materials which are include panel products such as plywood, particleboard, medium-density fiberboard, and (OSB) (Hu 2000).

(OSB) is a structural reconstituted panel that consists of wood strands glued with an exterior type waterproof resin (Papadopulos and Traboulay 2002).

When OSB roof or wall sheathing is exposed to environmental moisture, it is degraded (Brochmann et. all. 2004). There are many important factors which affect physical and mechanical properties of wood composite materials (Galbraith 1986).

Many researchers have studied the screw strength properties of wood composite materials by using various processing variables. The maximum holding strength of a screw is determined in part by the panel's internal bond. The denser boards tend to have the higher screw holding strength (Eckelman 1990). It was seen that demontable joints were more successful than stable joint in "T" joints used to the production of frame construction furniture (Imirzi 2000). Yapıcı *et al*. (2009) stated that as the increase of adhesive ratio, pres time and pres pressure, which were used to production of the oriented strand board, the nail withdrawal strength increase. And also, they were reported that the nail withdrawal strength values were changed between 124.60 and 334.81N.

The production conditions of OSB panels are effective on mechanical and physical properties OSB. The most important parameters affecting the properties of OSB are press pressure and pressing time. In this study, the aim is to evaluate the effects of press time and press pressure on screw strength of OSB.

MATERIAL AND METHODS

Mature Scots Pine wood (*Pinus sylvestris* L.) was used in the production of the (OSB). The strands dimension in usage was approximately 80mm long, 20mm wide and 0.7mm thick. First, the wood strands were dried to 3% moisture content before adhesive was sprayed on them for three minutes. Then, adhesive material without wax, a solid content of 47% liquid phenol- formaldehyde resin, was applied in 9 percent ratios based on the weight of oven dry wood strands.

The press periods and press pressure were 3, 6 and 9 minutes under the *2,94N/mm^2 and 4,90N/mm^2* press pressure, respectively. The shelling ratio was 50% for core layer and 50% for face layer, and density of the boards was aimed at 670kg/m^3 density. OSB panels, which were dimensioned as 56x56x1.2cm were made for experiments, in the six conditions. They were 12 in total as two for each. Hand formed mats were pressed in a hydraulic press. These panels were labeled from 1 to 6. All mats were pressed under automatically controlled conditions at 185±2ºC. After pressing, the boards were conditioned to constant weight at 65±5% relative humidity and at a temperature of 20±2ºC until they reached stable weight (TS 642 1997). The density, moisture content, modulus of rupture and modulus of elasticity values of OSBs were determined according to the related standards (TS-EN 323 1999, TS-EN 322 1999, TS EN 310 1999).

In measurement of screw strength values were determined using Zwick/Roell Z050 universal test device with capacity of 5000kg and measurement capability of 0.01Newton in accuracy. In testing, loading mechanism was operated with a velocity of 10mm/min. Data for each test were statistically analyzed. The analysis of variance (ANOVA) was used ($\alpha<0.05$) to test for significant difference between factors. When the ANOVA indicated a significant difference among factors, the compared values were evaluated with the Duncan test to identify which groups were significantly different from other groups.

RESULTS AND DISCUSSION

The density (D) and moisture content (MC) values of OSBs were determined according to the related standards. The average density and moisture content of panels were obtained as 710kg/m^3 and 7.4%, respectively. It was seen that the aimed and acquired D and MC values within the ranges specified in the related standards. The average and standard deviation of the values of the screw strength of produced panels are shown in the Table 1.

Table 1

Summary of the test results of the OSBs

Number of panel	Press pressure (N/mm^2)	Press time (minute)	Screw Strength (N)	
			Mean	Std. Dev.
1		3	784.54	149.20
2	2,94	6	846.20	121.95
3		9	988.60	114.53
4		3	699.16	143.08
5	4,90	6	745.35	339.09
6		9	777.55	275.85

It was found that the screw strength values of the test panels varied between 699.16 to 846.20 N. The lowest value for screw strength of produced panels was 699.16 N (4,90 N/mm^2 and 3 minutes press time). The variance analysis of screw strength based on manufacturing circumstances of test panels was done by using one-way variance analysis (Table 2).

Table 2

The result of variance analysis

	Source	Type III Sum of Squares	Df	Mean Square	F-Value	Sig.Level (p<0.5)
Screw Strength (N)	Corrected Model	359212.049a	5	71842.410	1.646	0.17
	Interecept	27345776.448	1	27345776.448	626.700	0.00
	Press pressure	184136.631	1	184136.631	4.220	0.04
	Press time	142202.109	2	71101.055	1.629	0.21
	Press pressure * press time	32873.309	2	16436.654	0.377	0.68
	Error	1570843.074	36	43634.530		
	Total	29275831.571	42			

According to the variance analysis, the effects of the both press time and press pressure on the modulus of elasticity values were not significant statistically. But, the only the effect of press pressure on screw strength value was statistically significant. Duncan test results conducted to determine the importance of the differences between the groups are given in Table 3.

Table 3

Duncan test Results

Number of panel	Press Pressure (N/mm^2)	Press Time (minute)	Screw Strength (N)	
			Mean	HG
1	4,90	3	699.16	A
2		6	745.35	AB
3		9	777.55	AB
4	2,94	3	784.54	AB
5		6	846.20	AB
6		9	988.60	B

It can say that screw strength values changed between 699 and 988N according to Duncan's test. Some homogenous groups were given the same column. It was seen that screw strength values were affected by changing press time and press pressure.

CONCLUSION

In this study, the values of screw strength which were among the most important mechanical features of oriented strand boards were determined according to related standard. Especially, it can be stated that as the press time increased, values of screw strength of test panels improved at the both press pressure. Although the highest screw strength was obtained from thirty samples as 988.60N, the lowest values of this were obtained from fourth samples as 699.16N.

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