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THE EFFECTS OF PRESS TIME AND PRESS PRESSURE ON THE MODULUS OF RUPTURE AND MODULUS OF ELASTICITY PROPERTIES OF ORIENTED STRAND BOARD (OSB) MANUFACTURED FROM SCOTS PINE.

Fatih YAPICI
Assoc.Prof.Dr. - Karabük University - Forestry Faculty
Department of Forest Industry Engineering, Karabük, Turkey
E-mail: fyapici@karabuk.edu.tr.

Raşit ESEN
Dr. - Karabük University-Technical Education Faculty
Department of Furniture and Decoration Education, Karabük, Turkey
E-mail: resen@karabuk.edu.tr.

Hüseyin YÖRÜR
Assist.Prof.Dr. - Karabük University - Forestry Faculty
Department of Forest Industry Engineering, Karabük, Turkey
E-mail: hyorur@karabuk.edu.tr.

Absract:

This study was carried out to determine the effects of pres time and pres pressure on modulus of rupture (MOR) and modulus of elasticity (MOE) properties of oriented strand board (OSB). For this purpose, 80mm long strands made of Scots pine (Pinus sylvestris L.) were bonded with phenol-formaldehyde resin at (6%) 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 3,92N/mm^2 and 4,90N/mm^2 press pressure, aiming for a target density of 670kg/m^3. It was showed that MOR and MOE values were changed between 25.88 – 35, 61N/mm^2 and 4888,54 – 5992,20N/mm^2, respectively.

Key words: *oriented strand board; phenol-formaldehyde; physical properties; mechanical properties.*

INTRODUCTION

The decline of a high quality wood supply has led to an increased demand for wood composite materials over the past forty years. The major advantage of wood composite materials manufactured from unused low quality wood and residues of other wood sectors. The wood composite materials which are include panel products such as plywood, particleboard, medium-density fiberboard, and oriented strandboard (OSB) (Hu 2000).

OSB is an engineered wood product that is manufactured wood particles known as strands, after bonded together with waterproof resin under pressure and heat (Baştürk 1999). Wood composite panels, such as (OSB), are widely used in many applications of the construction industry. First advantages of OSB are its equivalent mechanical properties and substantially lower cost compared to structural ply wood (Howard 2000). OSB industry was developed by using low-density hardwoods such as aspen, yellow-poplar, southern pine, lodge pole pine, jack pine, scots pine, and so on (Maloney 1996).

Avramidis and Smith (1989) and Tang *et al*. (1984) both stated that mechanical properties of OSB increased as resin ratio increased from 4 to 5 then 6%. Water absorption, thickness swelling and linear expansion properties improved with increasing resin ratio. Yapıcı (2008) stated that while increase of adhesive ratio and press time, improve of modulus of rupture and modulus elasticity values of OSB panels produced in three different adhesive ratio (3-4,5-6%), three different press time (3-5 and 7min.) and three different press pressure (35-40 and 45kg/cm2). When OSB roof or wall sheathing is exposed to environmental moisture, it is degraded (Brochmann *et al*. 2004). There are many important factors which affect physical and mechanical properties of wood composite materials (Galbraith 1986).

The mechanical and physical properties of OSB panels are effected many factors that are called type of raw material, adhesive type and ratio, press time and pressure. The most important parameters affecting the properties of OSB are press pressure and pressing time. The determination of effects of these factors on the physical and mechanical properties of panels is very important for manufacturing of OSBs. In this study, the aim is to evaluate the effects of press time and press pressure on modulus of rupture and modulus of elasticity 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 6 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 *3,92N/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 195±2ºC. After pressing, the boards were conditioned to constant weight at 65±5% relative humidity and at a temperature of 20±2 ºC 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 MOR and MOE values were determined using Zwick/Roell Z050 universal test device with capacity of 5000kg and measurement capability of 0.01 Newton 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 (α<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 modulus of rupture and modulus of elasticity of produced panels are shown in the Table 1.

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Table 1

Summary of the test results of the OSBs

Number of panel	Press pressure (N/mm^2)	Press time (minute)	MOE (N/mm^2) Mean	MOE (N/mm^2) Std. Dev.	MOR (N/mm^2) Mean	MOR (N/mm^2) Std. Dev.
1		3	5704.10	1855.49	29.66	8.66
2	3,90	6	5877.46	2245.07	31.05	8.97
3		9	5992.20	1920.75	35.61	6.06
4		3	4488.54	1634.15	25.88	3.61
5	4,90	6	4876.26	1812.34	32.59	5.08
6		9	5665.25	776.92	34,01	11.15

MOR and MOE values were two of the most common tests in the OSBs. It was found that the MOR and MOE values of the test panels varied between 25.88 – 35.61N/mm^2 and 4488.54-5877.46N/mm^2, respectively. The lowest value for MOR of produced panels was 25.88N/mm^2 (4,90N/mm^2 and 3 minutes press time). The variance analysis of MOR and MOE 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)
MOE (N/mm^2)	Press pressure	9705679.19	1	9705679.19	3.11	0.08
	Press time	4915828.17	2	2457914.08	0.79	0.46
	Press pressure * press time	1935288.37	2	967644.19	0.31	0.73
	Error	149848673.78	48	3121847.37		
	Total	1760918476.08	54			
MOR (N/mm^2)	Press pressure	22.12	1	22.12	0.37	0.54
	Press time	449.79	2	224.89	3.80	0.03
	Press pressure * press time	64.28	2	32.14	0.54	0.58
	Error	2843.36	48	59.24		
	Total	56849.99	54			

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 time on modulus of rupture 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

Press Time (min.)	MOE (N/mm^2) Mean	MOE (N/mm^2) HG	MOR (N/mm^2) Mean	MOR (N/mm^2) HG
3	5096,32	A	27.77	A
6	5376,86	A	31.82	AB
9	5828,73	A	34.81	B

It can be seen that the changed of MOE values at between 5096.32N/mm^2 and 5828.73N/mm^2 according to Duncan's test, and they were given the same homogenous groups. In addition, MOR values changed between 27.77N/mm^2 and 34.81N/mm^2, and they were given in the different homogenous groups.

CONCLUSION

In this study, the values of MOR and MOE, which were among the most important mechanical features of oriented strand boards, were determined according to related standard. Especially, it can stated that as the press time increased, values of modulus of rupture and modulus of elasticity of test panels improved at the both press pressure. Although the highest MOR value was obtained from thirty samples as 35,61N/mm^2, the lowest values of this were obtained from fourth samples as 25,88N/mm^2. Also, the results showed that the values of modulus of elasticity changed between 4488,54 and 5992,20N/mm^2. It can be said that the change of MOE value lower than MOR value according to statistical analysis.

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