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TECHNICAL NOTE

Characteristics of Particleboard Made from Sedar Chips and Wood Slabs

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ABSTRACT

This study was Characteristics of manufacture particleboard (PB) from sedar and wood slab of impregnated with UF. The chips were divided into coarse chips with dimensions of 2-4 mesh and fine chips of 30–60 mesh, urea formaldehyde (UF) resin solution at concentrations of 45 %, and 55% sprayed on these chips about 1 min until 10% to dry weight chips, they were dried under 5% moisture in a dram dryer before impregnated with resin. Three-layer mats with target densities of 0.70 g/cm3 were formed using fine chips for the face layer (20%) and back layer (20%) and coarse chips for the core layer (60%). A conventional hot press was used for fabrication of the PB, and the temperature, pressure and pressing time were 2.7 MPa, and 240 sec, respectively. The nominal dimensions of particleboard were 3660×1830×16 mm (thick). Result showed that the mechanical properties of PB increased with an increase in the percent of UF. They represented by efficacy between proportion of sedar with slab, also percent of surface with core layers. The bending strength, internal bonding strength, and thickness swelling (%) of the UF-impregnated particleboards exhibited excellent performances compared to those made in the past

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1. INTRODUCTION

Particleboard is famous product in wood industry and always been popular for use in furniture, architecture and indoor decoration. Due to its use for furniture, particleboard has always been the largest proportion of material used. The wood production consumption rate in 1990 was 3.6×109 m^3. By 2010, it is forecast to reach 5.1×109 m^3 [1]. We can see that with the advance of human civilization, the consumption of wood has increased; in general, the use of this material creates a lot of slab. The topics of consumption wood slab in more country are widely discussed in public and industry. Furthermore, wood slab are usually not included in any recycling lists. They are sent to combustion facilities. Recently, wooden slab are being into other wood products at an increasing rate. In these reuse products, particleboard has found typical applications as slabs [2], and it seems that the manufacture of particleboard from wood slab is the most common way to reuse them. Moreover, a series of studies has been conducted to investigate of mechanical properties and product quality assessment [3, 4]. The purpose of this study was to investigate the density, bending properties, internal bonding strength, and thickness swelling (TS) of particleboard made from different wood slab and species chips sedar, which were impregnated with urea formaldehyde (UF) resin.

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2. EXPERIMENTAL MATERIALS AND METHODS

2. 1. Materials Wood slabs were mixed from hircanian forest hardwood particular polar specie and sedar Chips was from region Gorgan, Iran. Slabs were prepared from new logs saw which were gathered. The adhesive used was a water-soluble UF resin (63% solid content and pH 7-7.5 produced by Samed, Co., Mashhad, Iran).

2. 2. Production process of PB Manufacture particleboard in Choube Shomal Company, Gonbad kavous, Iran. Chips were divided into two grades using 2-4 and 30-60 meshes, and were divided into coarse chips which passed through 2-4 mesh (stop on 2 mesh) and fine chips with through 30 mesh (stop on 30 mesh).

They were dried under 5% moisture (MC) in a dram dryer before impregnated with resin. Then, water-soluble urea formaldehyde (UF) resin solution at concentrations of 45 %, and 55% sprayed on these chips about 1 min until 10% to dry weight chips. The UF resin absorption content can be expressed as where RC [5] is the UF absorption content, W1 is the oven dried weight of the chips before spray of resin, and W2 is the oven-dried weight of chips after then.

$$RC\ (\%) = (W2 - W1/\ W1) \times 100 \quad (1)$$

Next, the chips were formed by industry forming. The particleboard was formed using fine chips for the face layer (20%) and back layer (20%) and coarse chips for the core layer (60%). A conventional hot press was used for fabrication of the particleboard and the temperature, pressure and pressing time were 2.7MPa and 240sec, respectively. The nominal dimensions of particleboard were 3660×1830×16mm (thick), with three Layers. The thickness of particleboard was controlled by press balance system and spacer. Two kinds of target concentrations of resin and proportion between slab and sedar (C1 was 45 %, and C2 was 45 % concentrations. In addition, S1 was 30 - 70% slab and S2 was 50 - 50 % proportion of slab to sedar) were fabricated in this study.

2. 3. Testing Method The particleboards produced for this study were tested under EN standard. The full panels of each particleboard were prepared for mechanical tests. The boards were conditioned at room temperature and a relative humidity of 65±2% for one week. Thickness swelling, modulus of elasticity, modulus of rupture and internal bonding were tested based on DIN EN 317 and DIN 68754 [6]. Results were analyzed statically based on a full factorial design and Duncan test was used to compare means. They were tested for their density and moisture content (MC), which used the following formulae:

$$MOE\ (MPa) = \frac{P_{bp}L^3}{4bh^3Y_p} \quad (2)$$

$$(g/cm3) = (Wa\ /\ Va) \quad (3)$$

Wa is the air-dried weight, Va is the air-dried volume, and W0 is the oven-dried weight of the particleboard and W1 is early weight .

The MOR and MOE of each specimen are represented by the following formulae:

$$MC\ (\%) = (W1 - W0\ /\ W0) \times 100 \quad (4)$$

$$MOR\ (MPa) = \frac{3P_bL}{2bh^2} \quad (5)$$

MOR is static bending strength (MPa), MOE is static bending modulus of elasticity (MPa), Pb is maximum load (N), Pbp is the load at the proportional limit (N), Yp is the deflection corresponding to Pbp (mm), b is the width of the specimen (mm), h is the thickness of the specimen (mm), and L is the span (mm).

The tensile strength perpendicular to the surface was determined using nine square conditioned specimens of 5 × 5cm from each panel according to EN standard [7]. The rupture load (Ps) was determined and IB strength was calculated from the following formula:

$$IB\ (MPa) = Ps\ /\ A \quad (6)$$

IB is the internal bond strength, Ps is the rupture load, and A is the surface of the specimen .

Conditioned samples, 10×10 cm for the evaluation of TS were prepared according to EN standard [7]. The thickness at the middle of the test specimen was measured with a micrometer. Then, the test specimens were soaked for 2 and 24 h for measurement of the thickness. The TS rate was determined from the following formula:

$$TS_2\ (\%) = (t_2\text{-}t_0) \times 100 \quad (7)$$

$$TS_{24}\ (\%) = (t_{24}\text{-}t_0) \times 100 \quad (8)$$

TS is the thickness swelling rate, t_0 is thickness at the middle of the test specimen before soaking in the water, and t_2 and t_{24} are the thicknesses in the middle of the test specimen after soaking into water for 2 and 24 h, respectively.

All samples were comparison with untreatment sample. Untreated were only from different forest hircanian hard wood (oak, acre, beech and…) with 10% UF resin 50% concentrations.

3. RESULTS AND DISCUSSION

In this study, UF resin was with concentrations of 45 % (C_1) and 55 % (C_2). Furthermore, S1 was 30 – 50 % slab and S2 was 50-50 % proportion of slab to sedar. It was found that perpetrate mechanical increased with an increase in the UF resin concentrates the treatment. The previous study also indicated that a high correlation existed between the resin absorption content and treatment concentration for particleboard and OSB with Urea and phenol formaldehyde [8]. Analysis of variance (ANOVA) showed significant effects of the treatments (C_1-C_2- S_1- S_2 and their interaction) on Thickness Swelling (TS) of test specimens after 2 and 24 hours of soaking in water, MOE, MOR and Internal Bonding (Table 1). ANOVA showed that C1 and C2 are significant - on treatments. Maximum effect was on IB. MOR and MOE have different effect by treatments.

Values of MOR, MOE and IB of particleboard are shown in Table 2. Results indicated that the values of MOR and MOE of particleboards manufactured in our study were higher than untretment particleboards.

TABLE 1. Analysis of variance for applied treatments

Treatments		Independent				Interaction			
		C1	C2	S1	S2	C1S1	C1S2	C2S1	C2S2
TS	2 h	**	**	*	*	ns	ns	*	**
	24 h	*	*	ns	ns	*	*	*	*
MOE		**	**	*	ns	*	ns	*	ns
MOR		**	**	*	*	*	ns	**	**
IB		**	**	*	*	*	*	*	**

**: Significant at 99%; *: Significant at 95%; ns: Not significant

TABLE 2. Valuation of mechanical properties treatments and un treated samples

Factor (MPa)	Treatments							
	C1	C2	S1	S2	C1S1	C1S2	C2S1	C2S2
MOE	1850	2700	5360	4235	5500	6580	6750	5760
MOR	12.1	14.2	16.5	15.6	16.9	17.5	18.2	17.6
IB	0.28	0.39	0.61	0.56	0.57	0.77	0.81	0.78

Whose MOR range from 12.1 to 17.6 MPa; similar results were also obtained for particleboard made out of many research [17, 18]. The distribution of UF resin on the surface and back of the particleboard could be more even and dense because of bulk density. Thus, values of the MOR and MOE could be even higher [9]. Some studies on the soft woods density in profile of panels indicated that the bending strength depends on the pick density, mean density, and other density parameters. Low density of chips has relative higher effect on both MOR and MOE at high MD level in panel [10]. Low density of wood (similar soft wood) was factor affecting MOE and MOR [11]. It was found that the values of MOR and MOE increased with an increase of resin (see Figure 1).

A higher value of the IB strength of different particleboard treatments were observed in our study because of more distribution of the UF resin on the chips and more links in panels.

The IB values of particleboard in our study were superior to those (0.2–0.81 MPa) of particleboards manufactured untreated (see Figure 2)

Compared particleboard made by mixed species included oak, spruce, beech and other hardwoods with treatment samples show that IB by treated have increase (see Figure 3). The IB value in our study was also higher than untreated. Moreover, values of IB increased with an increase in the values of percent resin and sedar to wood slabs proportion. This result is in agreement with a previous report in which a high correlation existed between percent resin measured and IB for the particleboard. The previous studies also indicated that correlation existed between the values of the sedar chips and IB impregnated OSB and PB [8, 9, 12].

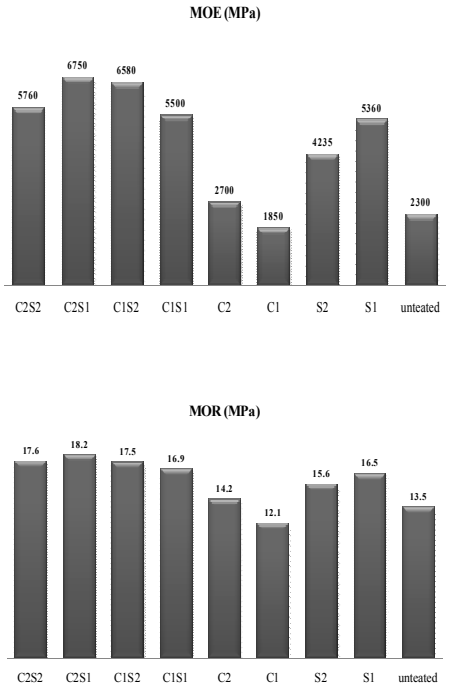

Figure 1. Valuation treatments on MOR and MOE comparison with untreated

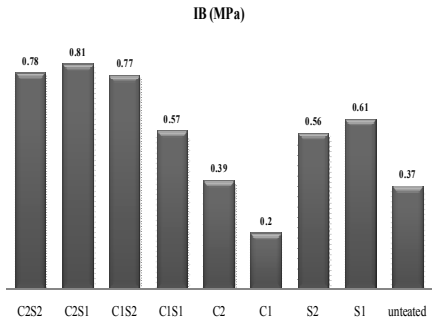

Figure 2. Valuation treatments on **IB** and comparison with untreated

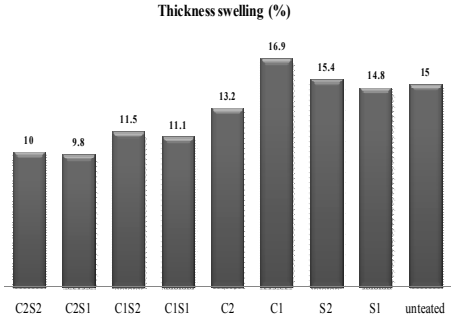

Figure 3. Valuation treatments on TS and comparison with untreated (2 h)

This in study C_2S_1 group was best treatment. Results showed that the values of mechanical properties of particleboards manufactured in our study for group C1 was lower than untreated (Table 2) also showed that the mechanical properties increased with an increase in the treatment percent resin or wood slabs proportion or both treated. In our study, we found the mechanical properties of groups single were lower than that of the group's composite treatment. The reason is that when the same density of wood materials are dominant in a process, the compaction ratio increases, which increases the mechanical properties. A negative correlation between the values wood slabs with mechanical properties showed in results. Values of the thickness swelling (%) of UF resin particleboard after treatment in water for 2 and 24 h are shown in Figure 3.

A similar correlation existed thickness swelling (%) of OSB and the PF resin content, after 2 and 24 h [13]. Thickness swelling (%) was increase with an increase of resin or proportion sedar chips to wood slabs. A lower value of thickness swelling (%), different particleboard treatments were observed, because of the more distribution of the UF resin on the chips and more links in panels. In addition, dense particleboards increase because of low density of sedar chips.

Generally, in particleboard, the strongest interaction happens when a covalent bond forms between the adhesive and the substrate which cause a decrease in thickness swelling and an increase in mechanical properties. The relationship between TS and percent sedar show that TS increase with a decreased in percent sedar.

However, for wood adhesion, this has been an area of great debate, because of the difficulty in determining the presence of this bond type given the complexity of both the adhesive and the wood and the difficulty of generating a good model system. Since wood has hydroxyl groups in its three main components cellulose, hemicelluloses, and lignin and also many of the adhesives can react with hydroxyl groups, it is logical to assume that these reactions might take place. However, others contend that the presence of large amounts of free water would disrupt this reaction [14, 15]. It seems that the increase percent resin can coated surface the panel more easily, resulting in higher protection against moisture [16]. On the other hand, higher pressure needed to consolidate the OSB mat results in an increased spring back, which can partially explain the lower improvement in TS observed in this study [17].

4. CONCLUSION

This study focused on Characteristics of manufacture particleboard from sedar and wood slab with UF. Experimental result showed that the UF resin absorption content of chips increased with an increase in the concentration of UF solution. Their represented could be by efficacy between proportion of sedar with slab and also percent of surface with core layers. In addition, the positive relationships between the resin content of the chips and the MOR, MOE, and IB values could be represented to be significant. However, the TS of particleboards decreased with an increase in the UF resin content of the chips.

5. ACKNOWLEDGEMENTS

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چکیده

در این تحقیق، خصوصیات تخته خرده چوب ساخته شده از چوب سوزنی برگان در مخلوط با چوب ضایعاتی پشت لا آغشته شده با چسب اوره فرمالدهید مورد بررسی قرار گرفت. ذرات آماده برای لایه میانی با مش ۲ تا ٤ و برای لایه سطحی با مش ۳۰ تا ٦۰ انتخاب شدند. غلظت چسب برای لایه سطحی ٤۵ و لایه میانی ۵۵ درصد انتخاب شد. چسب با نسبت ۱۰ درصد نسبت به وزن ذرات چوب با رطوبت ۵ درصد اضافه شد.کیک ۳ لایه با نسبت ٦۰ درصد برای لایه میانی و ۲ لایه سطحی (هر کدام ۲۰ درصد برای ساخت تخته خرده چوب با دانسیته ۰/۷ گرم بر سانتی متر مکعب انتخاب شد. مولفه های پرس با زمان ۲٤۰ ثانیه و فشار ۲,۷ مگاپاسکال تعیین شد. ابعاد تخته۱٦×۳٦٦۰×۱۸۳۰ میلیمتردر نظر گرفته شد. نتایج نشان دادند خصوصیات مکانیکی محصول با افزایش چسب بهبود می یابد. این اثر می تواند تحت تاثیر نسبت ضایعات پشت لا با چوب سوزنی برگ و اثر نسبت لایه سطحی به میانی تخته باشد.

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