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Producing Particleboard Using Of Mixture of Bagasse and Industrial Wood Particles

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Abstract. In this study feasibility of using of mixture of bagasse and industrial wood particles for producing single and three layer particleboard . The aim of this study was to consider bagasse as partially substitute particleboard industry raw material. Variables were type of board at two levels (single and three layer), percentage of added bagasse to industrial particles at 4 levels (20%,30%, 40% and 50%) , and press temp. at two levels (165OC and 180 OC). In producing three layer particleboard wood and bagasse particles were separated and placed in different layers so that bagasse particles were located in the face layers and wood particles were placed in the core of board. But in one layer particleboard bagasse and wood particles were used in the form of mixture. Effect of variables on physical and mechanical properties of particleboard were determined. Results showed that in three layer particleboard physical and mechanical properties were better than single layer particleboard. Increasing press temperature caused improvement in particleboard properties in most cases due to intermeshing and increasing softening wood and bagasse particles. The optimum treatment in this study was found to be adding 50% bagasse and press temperature of 180 OC.

Introduction

Regarding raw material demand for particleboard industry and reduction of wood supply from natural forest due to environmental concerns utilization of alternative lngno-cellulosic materials such as bagasse is unavoidable. Compared with other ligno-cellulosic material such as wheat straw, reed and sunflower stem, bagasse is the most suitable material for manufacturing particleboard. This contains 53.4% cellulose, 18% lignin, 1.6% extractives and 0.08 % ash. Its fiber length is 1.5 mm which is suitable for making particleboard [1, 8 and 9]. Only 16% of bagasse is used in wood industry from this 2.4% is consumed for making particleboard [2]. Particleboard made from bagasse meets properties of particleboard manufactured from wood particles. Regarding low density and log fiber of bagasse, it can modify properties of particleboard made from heavy species such as eucalyptus when only particles are mixed whit their particles [3]. On the other hand, bagasse improves surface roughness of particleboard which is very important in finishing particleboard [3] . The aim of this study was to investigate on effect of bagasse on properties of particleboard manufactured from mixture of baggase and wood particles.

Materials and Methods

Bagasse was provided from a local sugar mill located in Shoshtar, South of Iran. Bagasse was dried to 4%. Industrial particles were provided from local company. Urea formaldehyde resin and ammonium chloride were provided by a local adhesive company. Amount of bagasse added to industrial particles at three levels (20%, 30, and 50%), press temperature at two levels (165^{O}C and 180^{O}C) and panel type at two levels (one layer and three layers). In total forty eight panels were manufactured. In manufacturing three- layer panels, bagasse was used as surface layers. Mechanical properties of panels such as modulus of rupture (MOR), modulus of elasticity (MOE) and internal bond (IB) were evaluated following DIN 68793 and thickness swelling (TS) was evaluated based on ASTM 1037. Data was analyzed using ANOVA by SPSS software.

Results and discussion

Observations of experiments are shown in Table 1. and results of analysis of variances are shown in Table 2.

Table 1. Treatments and observations

Treatment	panel	Bagasse %	Press Temp. ^{O}C	Density	MOR MPa	MOE MPa	IB MPa	TS %
1	One layer	20	165	0.65	11.60	1549	0.54	12.7
2	One layer	20	180	0.66	10.00	1420	0.81	11.9
3	One layer	30	165	0.65	12.90	1269	0.51	14.8
4	One layer	30	180	0.65	11.30	1353	0.75	13.7
5	One layer	40	165	0.64	13.50	1193	0.42	15.9
6	One layer	40	180	0.64	13.00	1248	0.61	15.1
7	One layer	50	165	0.64	14.10	1020	0.39	17.5
8	One layer	50	180	0.65	14.00	1086	0.57	15.5
9	Three layer	20	165	0.63	9.00	1130	0.31	21.2
10	Three layer	20	180	0.63	10.00	1380	0.39	18.1
11	Three layer	30	165	0.64	11.00	1319	0.47	18.1
12	Three layer	30	180	0.65	13.00	1679	0.57	15.9
13	Three layer	40	165	0.66	14.00	1919	0.51	16.1
14	Three layer	40	180	0.67	15.00	2103	0.63	15.2
15	Three layer	50	165	0.67	16.00	1966	0.65	14.3
16	Three layer	50	180	0.69	12.96	2550	0.77	12.8
control	Three layer	-		0.65		1458	0.45	12.4

Table 2. Results of analysis of variance (ANOVA)

variables	TS	IB	MOE	MOR
Panel type 1	* *	* *	* *	* *
Bagasse 2	ns	* *	* *	* *
Press temp. 3	* *	* *	* *	*
1 X 2	* *	* *	* *	* *
1 X 3	ns	* *	* *	* *
2 X 3	ns	* *	ns	ns
1 X 2 X 3	ns	**	ns	ns

** = 99% confidence, *= 95% confidence , ns = not significant

Based on Table 2. effect of panel type on MOR is significant with 99 % confidence. This effect is shown in Fig. 1.

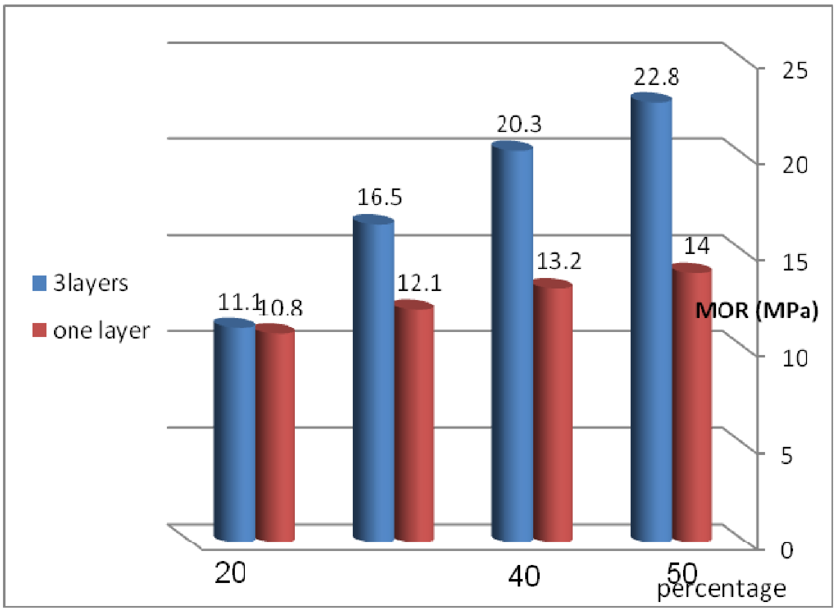

Fig. 1. Interaction effect of bagasse and panel type on MOR

As seen all panels made of 80% wood particles and 20% bagasse showed higher MOR. It is also obvious that by increasing amount of bagasse in the mixture, MOR increases which indicates that bagasse has strong effect on MOR of panel due to its slenderness ratio. Hiziroglu et al. 2005 [5] also mentioned that layering of particleboard increases its mechanical properties. Effect of bagasse on MOR of panels is shown in Fig. 2. As seen by increasing bagasse from 20% up to 50% MOR is increased. When bagasse was added to industrial particles, MOR of panels increased except when only 20% bagasse was added. This effect is attributed to high slenderness ratio of baggase particles. Alfonso and Herryman (1990) [2] also mentioned this effect. Effect of bagasse on panel IB is shown in Fig. 3. As seen in this figure IB of panels increase when bagasse is increased in the mixture.

The same effect was observed for modulus of elasticity. Interaction effects of panel type and bagasse on panel IB are shown in fig. 3. As seen by increasing of bagasse added to the mixture of panels IB increased and IB of all panels made of mixture of bagasse and industrial wood particles is higher than that of control. Interaction effects of panel type and bagasse are shown in Fig. 4. The highest IB (0.71 MPa) is seen in three layer panels in 50 % bagasse and after that the IB of one layer panel (0.61 MPa) in which only 20% bagasse is used.

These two results are seemed to be contradictory but they are actually not because internal bond is a characteristics which indicate strength of bond between particles specially in the core of panels. In one layer panels in which amount of bagasse is low the negative effect of slenderness on IB is weak so panels presented high IB but when the amount of bagasse increases in one layer panel this negative effect dominates and causes reduction of IB. In three layer panels in which industrial wood particle placed in the core the presence of baggase in the faces has slight effect on internal bond so that even using 50% bagasse in the faces of panels has no effect on IB this is the reason that three layer panels with 50% bagasse present the highest IB. The effect of bagasse on thickness swelling is not significant fig. 5 but interaction effects have significant effect on thickness swelling fig. 6. Usually when light material such as bagasse and other agricultural residuals are used in manufacturing wood composites [7], thickness swelling of products is higher compared with products made of wood [6]. It can be seen that three layer panels generally present higher thickness swelling than one layer panel. This indicates that when non-wood material is used on the surface of composites where the most moist exposure takes place panels are not stable because of non wood material like bagasse is lighter and its structure is less compact compared with wood.

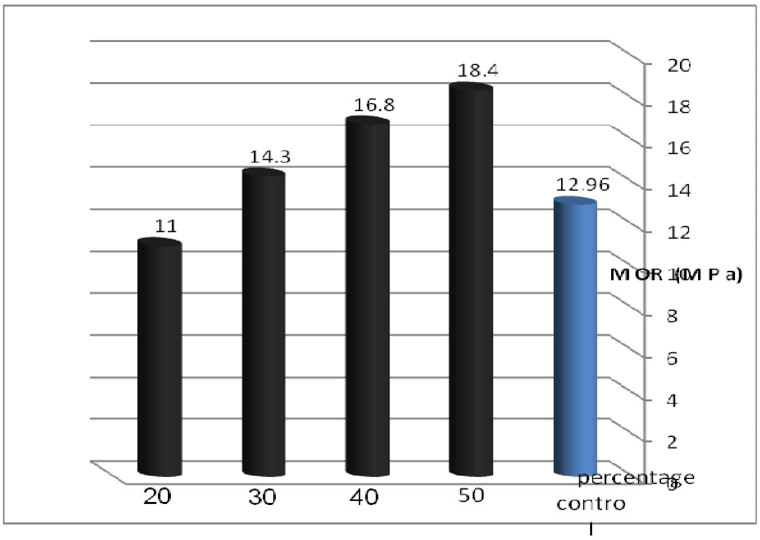

Fig. 2. Effect of Bagasse on MOR

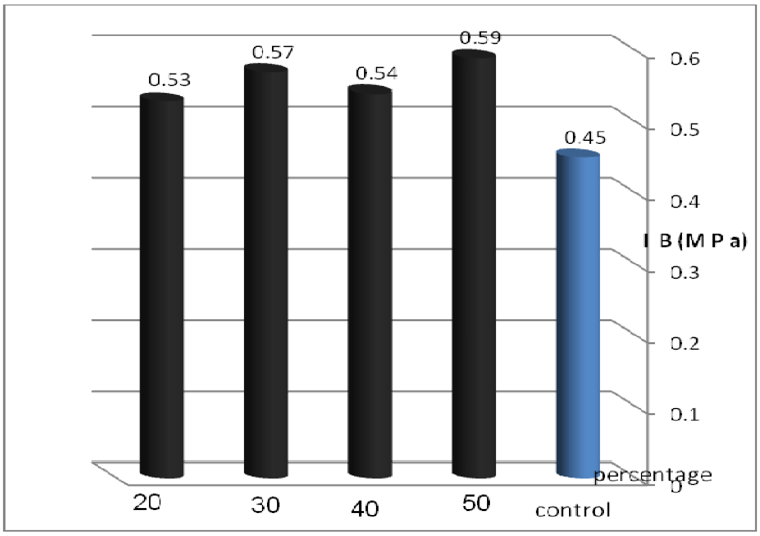

Fig. 3. Effect of bagasse on IB

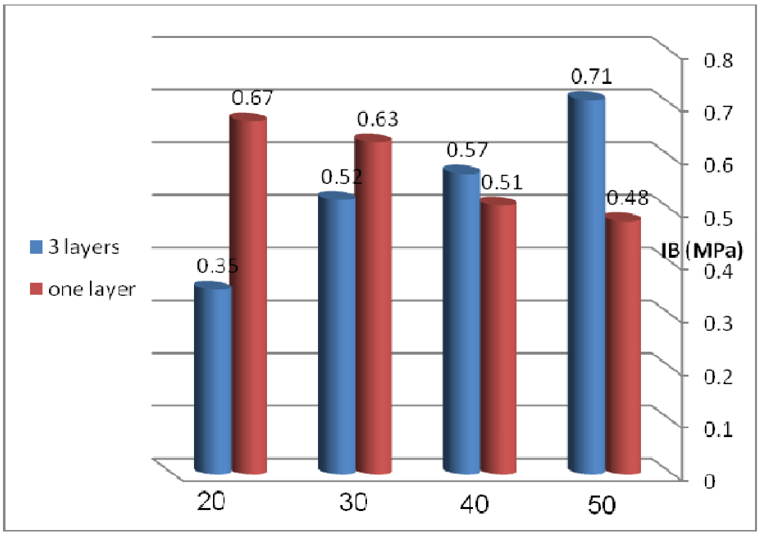

Fig. 4. Interaction effect of bagasse and panel type on IB

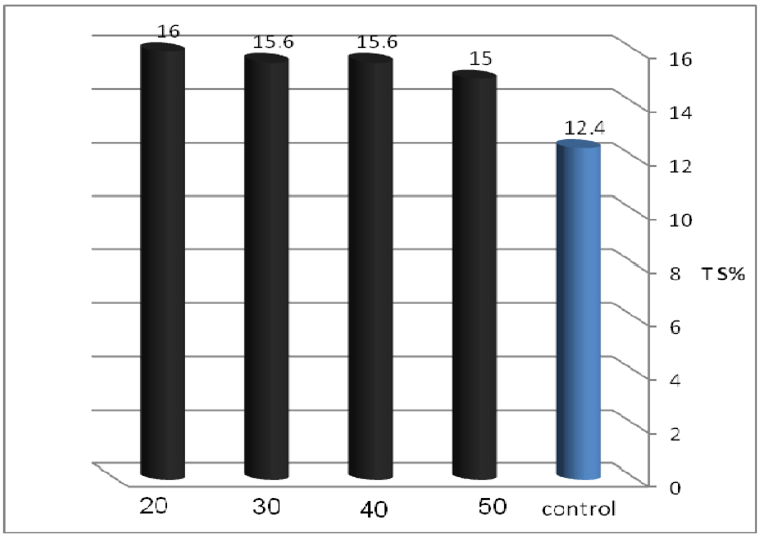

Fig. 5. Effect of bagasse on TS

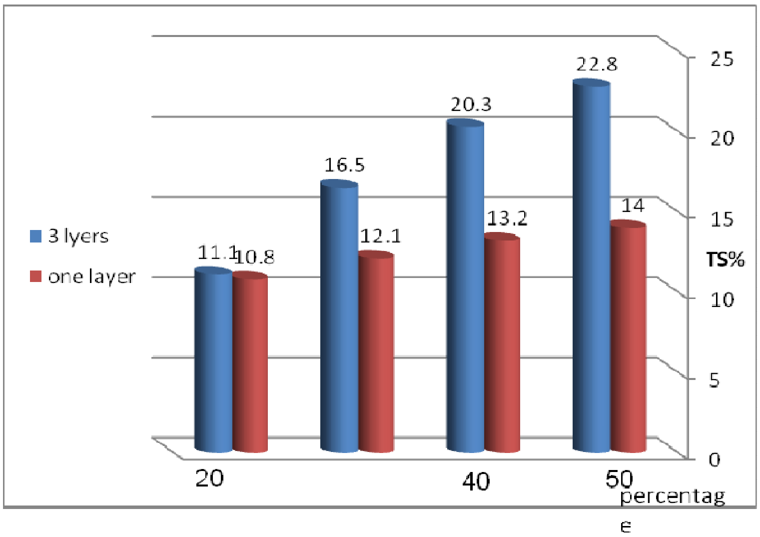

Fig. 6. Interaction effect of bagasse and panel type on TS

Summary

Results of this study indicate that bagasse a non wood ligno cellulosic material would be a good potential for wood substitution. This material not only saved natural forest but also improved most of applied properties of manufactured panels. Since bagasse produced light and slender particles it is very promising material to improve mechanical properties and even surface roughness of particleboard

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