PROPERTIES OF HOMOGENOUS MUF PARTICLEBOARD FROM BAMBOO (*GIGANTOCHLOA SCORTECHINII*)

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ABSTRACT

In the study of high moisture resistant particleboard from bamboo (Gigantochloa scortechinii), homogenous melamine urea-formaldehyde particleboard was produced. For homogenous board, increase in resin content was accompanied by an increase in the mechanical and improvement in water absorption and thickness swelling properties. Varying the particle sizes also showed differences in the mechanical and physical properties. Wax increased the water resistance of the board but decreased the mechanical properties. All boards surpassed the minimum requirement of the BS for the mechanical and physical properties. Particles from three-year-old Gigantochloa scortechinii was found to be suitable for the making of homogenous melamine urea-formaldehyde particleboard.

INTRODUCTION

All over the world the forest resources are dwindling due to the development of the wood industry and population increase has increase tremendous pressure on the needs for new raw materials. Bamboo plantation now plays a crucial part of social forestry in many developing countries. The world over there is 1,250 species of bamboo and occupies about 14 million hectares and distributed mainly in the tropical and subtropical zones (Zhu 1995). However, most of the bamboo forests in the world are not managed intensively and are usually characterized by low productivity.

In Malaysia, of the 50 bamboo species found, 13 are being widely used in the various bamboo industries.bamboo. Buluh semantan (*Gigantochloa scortechinii*) is the commonest bamboo found in the wild and presently are used in large quantities in the manufacture of basakets, higo products, incense sticks and parquetries (Abd. Latif 1987). The basic properties of *G. scortechinii* have been reported by Abd. Latif et al. (1994) and Abd. Latif (1996). However no published report on its utilisation in the making of composite products has been found. This paper discusses the particleboard properties of single- and three- layer particleboards produced with melamine urea formaldehyde (MUF) resins. The influences of particle size, resin content and wax addition are included in the discussion.

MATERIALS AND METHODS

Sixty bamboo clums from three-year-old bamboo (*Gigantochloa scortechinii)* were harvested from managed bamboo clumps in FRIM, cut into 2 m length and splitted longitudinally using a bamboo splitter. The bamboo splits were fed into the Pallmann drum chipper and the chips produced were then flaked in the Pallmann drum flaker. After flaking the particles were air-dried for one week to reduce the moisture content prior to oven-drying and were subsequently placed in an oven at 60 C until the moisture reaches about five percent. The oven-dried particles were then screened into less than 0.5, 0.5-1.0, 1.0-2.0 and more than 2.0 mm sizes using a circular vibrating screen.

In the manufacture of homogenous board, three different resin contents were applied ; 8, 10 and 12% using three different particle sizes of 0.5-1.0, 1.0-2.0 and > 2.0 mm. One percent wax was added while no wax was used for the controlled boards. The melamine urea-formaldehyde resin used in the study had a solid content of 65%. The hardener (ammonium chloride) solution with a concentration of 20% was used. The amount of hardener added was equivalent to 3% of the weight of the resin solution used.

For board manufacture a weighted amount of particles was placed in the Drais glue mixer and sprayed with a resin mix containing resin, hardener, wax and water. The glue mix was sprayed as a fine mist at an air pressure of 0.4 MPa in order to obtain an even distribution of resin over the bamboo particles. After spraying, the sprayed particles were then manually laid in a wooden mould over a caul plate with a dimension of 34 x 34 cm and then pre-pressed with a cold press at 3.5 MPa for 30 seconds. The consolidated mat was then finally pressed to the required thickness of 12 mm at 160°C for 6 minutes with the maximum pressure at the metal stops at 120 kg cm-2. The target density was approximately 721 kgm^{-3}. A total of three boards were produced for each condition.

All the boards produced were cut according to a cutting plan adopted from BS EN 326-1: 1994 (Anonymous 1994) made to obtain a random selection of test samples throughout the board size of 340 x 340 mm. The test samples were tested for its mechanical: modulus of rupture (MOR), modulus of elasticity (MOE) and internal bond(IB), and physical properties: water absorption (WA) and thickness swelling (TS) according to British Standard BS EN : 1993 (Anonymous, 1993). Screw withdrawal (SWE & SWS) tests were conducted according to BS 5669

(Anonymous 1989). All the mechanical tests were conducted using an Instron Universal Testing Machine Model 4204.

PHYSICAL AND MECHANICAL PROPERTIES

The properties of single-layer MUF particleboard produced from three-year-old *G. scortechinii* are shown in Table 1. Boards produced from particles of greater than 2.0 mm with 12% resin and 1% wax gave the highest MOR (29.72 MPa) while those produced by PS 0.5-1.0 mm with 12% resin and wax had the highest MOE (4795 MPa). The highest IB (1.16 MPa) was shown by boards made from PS of 1.0-2.0 mm with 12 % resin without the addition of wax while boards produced from PS 0.5-1.0 mm had the highest SWS (1042 N) and SWE (932 N). The lowest TS1(1.49%), TS24(7.29%), WA1(3.76%) and WA24(19.95%) are produced from PS of 0.5-1.0 mm with 12 % resin and 1% wax.

Generally, bigger PS showed better MOR, MOE and IB but lower SWS and SWE values. Higher MOR with the larger PS could be attributed to the ability of larger PS to distribute stress over a larger surafce per unit weight and the increase in total glue bonded area. Internal bond and screw withdrawal values on the contrary decrease with increment of PS. The higher IB and SW with smaller PS can be due to the fact they can be well intermeshed and well-bonded to give gap-free boards. The internal discontiunity factor also gives the board higher IB and SW values. However, the dimensional stability of the boards are reduced since with bigger PS the existence of larger voids leads to easier intake of water into the board. Furthermore, since bigger PS possess higher bending strength, the stress levels becomes higher and once released would increase the water absorption capability and thus give rise to higher WA and TS. Shaikh (1991) also reported similar trends in the WA and TS properties of big particles.

Increase in resin content exhibited an increasing trend for the strength properties and improved the board stability towards water exposure. This is obvious since at higher resin content more resin are available for inter-particle bonding thus increasing the mechanical and physical properties

With wax addition the strength properties of MOR and MOE showed slightly higher values but the decreased the IB, SWS and SWE. The reduction in mechanical properties is probably due to the resistance characteristics of wax, which reduced the particles ability to bond intimately. The dimensional stability of the boards was greatly improved with the presence of wax. In general, all the boards produced from three-year-old *G. scortechinii* particles surpassed the minimum requirement of the BS and MS standards and the particles are therefore suitable for the manufacture of MUF particleboards.

Table 1: Properties of MUF Single-layer Particleboard from Three-y-old *G. scortechinii*

PS mm	ID	Wax (%)	Resin (%)	Den Kgm^{-3}	MOR (MPa)	MOE (MPa)	IB (MPa)	SWS (N)	SWE (N)	TS1 (%)	TS24 (%)	WA1 (%)	WA24 (%)
0.5-1.0	H0.5	0	8	743	22.04	2920	0.83	814	738	4.28	16.44	16.27	62.12
			10	760	24.54	3309	1.02	1004	824	3.25	11.51	12.16	47.30
			12	750	28.22	3596	1.04	1042	932	2.63	9.48	10.23	34.69
1.0-2.0	H1.0	0	8	736	22.13	3167	0.75	705	687	8.33	23.59	33.17	74.37
			10	735	24.15	3336	0.94	874	810	5.93	17.07	22.11	58.65
			12	719	26.03	3639	1.16	979	904	3.93	12.57	14.93	51.69
>2.0	H2.0	0	8	768	22.67	3115	0.80	786	727	4.39	21.19	20.22	60.16
			10	781	25.87	3468	1.04	1003	884	3.39	15.52	17.23	46.64
			12	766	28.38	3830	1.14	945	900	2.37	11.19	11.23	36.68
0.5-1.0	HW 0.5	1	8	758	23.04	3978	0.71	765	722	2.31	9.97	5.49	27.20
			10	762	25.85	4530	1.04	842	770	1.96	8.09	4.00	21.33
			12	763	28.00	4795	1.05	890	859	1.49	7.29	3.76	19.95
1.0-2.0	HW 1.0	1	8	746	22.03	3259	0.74	713	581	3.10	11.88	6.92	29.97
			10	735	23.96	3615	0.90	746	648	2.54	9.90	6.01	29.17
			12	764	27.15	3781	0.94	794	665	1.99	8.07	5.21	24.32
>2.0	HW 2.0	1	8	765	22.81	3388	0.58	803	660	2.67	14.01	7.44	30.30
			10	787	27.51	4017	0.70	902	745	2.02	10.59	6.51	26.29
			12	784	29.72	4317	0.91	922	825	1.63	7.59	5.29	20.73
BS		**5669**			**min. 13.8**	**min. 2000**	**min. 0.34**	**-**	**min. 360**	**max. 8.00**	**-**	**-**	**-**

Note: PS = Particle size, MOR = Modulus of Rupture, MOE = Modulus of Elasticity, IB = Internal Bond, SWS = Screw Withdrawal surface, SWE = Screw withdrawal edge, TS1 = Thickness swelling after 1 hour, TS24 = Thickness swelling after 24 hours, WA1= Water absorption after 1 hour, WA24 = Water absorption after 24 hours, H0.5=Homogenous board made with 0.5mm particles, HW0.5= homogenous board made with 0.5mm particles with 1% wax

CONCLUSION

From the study it was shown that particleboard made from bigger particles showed better mechanical properties in terms of modulus of rupture, modulus of elasticity and internal bond but lower dimensional stability as compared to those made from smaller particles. Increased resin content exhibited an increasing trend for all the strength properties and improved the dimensional stability of all the boards. Wax addition decreases the value of internal bond and screw withdrawal but greatly improved the dimensional stability of the boards. In general, particles produced from three-year-old bamboo are suitable raw materials for the manufacture of melamine urea formaldehyde particleboards.

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