Strength Properties and Dimensional Stability of Particleboard made from Furniture Wastage

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Abstract

An experiment was conducted to find out the strength properties and dimensional stability of particleboard using waste wood and planer shavings collected from Bangladesh Forest Industries Development Corporation (BFIDC). Waste wood were converted into chips. Particleboards were fabricated at five different ratios of wood chips and planer shaving such as 100:0, 75:25, 50:50, 25:75, and 0:100. Results show that particleboards made from 100% planer shavings have good static bending properties (143 kg/cm^2) and excellent tensile strength (13 kg/cm^2). Both the values satisfy the Indian and British standard. The percentage of thickness swelling and water absorption were measured after 2 and 24 hours soaking in water. Lowest thickness swelling and water absorption were found in the board made of 100% planer shavings. Particleboards made from 75% and 50% planer shavings also satisfy the Indian standard. It is concluded that planer shavings from different wood based industries can be used for making conventional particleboard of high strength properties.

সারসংক্ষেপ

বাংলাদেশ বন শিল্প উন্নয়ন কর্পোরেশন (বি এফ আই ডি সি) হতে সংগৃহীত ফেলনা কাঠ ও রাঁন্দার পাতলা ফালি ব্যবহার করে পার্টিকেল বোর্ড তৈরির উপযুক্ততা যাচাইয়ের পরীক্ষা চালানো হয়। ফেলনা কাঠগুলোকে কুঁচিতে রূপান্তরিত করা হয়। কাঠের কুঁচি বা রাঁদার পাতলা ফালি দিয়ে পাঁচটি বিভিন্ন অনুপাতের পার্টিকেল বোর্ড তৈরী করা হয়। অনুপাতগুলো হল ১০০ঃ০, ৭৫ঃ২৫ ৫০ঃ৫০, ২৫ঃ৭৫ এবং ০ঃ১০০। ফলাফল বিশ্লেষনে দেখা যায় যে, ১০০% রাঁদার পাতলা ফালি দিয়ে তৈরীকৃত পার্টিকেল বোর্ডের static bending (143 kg/cm^2) এর মান ভাল এবং আভ্যন্তরীন বন্ধন শক্তির (13 kg/cm^2) মান উত্তম। উক্ত উভয় শক্তির মানই ইন্ডিয়ান ও বৃটিশ ষ্টান্ডার্ড এর শর্ত পুরন করে। সব ধরনের বোর্ড ২ ও ২৪ ঘন্টা ব্যাপি পানিতে চুবিয়ে শতকরা পুরুত্বের স্ফিতি ও পানি শোষন পরিমাপ নির্ণয় করা হয়। ১০০% রাঁন্দার পাতলা ফালি দিয়ে তৈরী কৃত বোর্ডে সবচেয়ে কম পুরুত্ব স্ফিতি এবং পানি শোষন পাওয়া যায়। ৭৫% ও ৫০% রাঁন্দার পাতলা ফালি দিয়ে তৈরীকৃত পার্টিকেল বোর্ডের শক্তিকৃত মান ইন্ডিয়ান ষ্টান্ডার্ড এর সমমান। অতএব, বিভিন্ন কাঠ ভিত্তিক শিল্প প্রতিষ্ঠান হতে প্রাপ্ত রাঁন্দার পাতলা ফালি ব্যবহার করে উল্লেখযোগ্য শক্তি সম্পন্ন প্রচলিত পার্টিকেল বোর্ড তৈরি করা যায়।

Keywords: Internal bond strength, modulus of rupture, planer shavings, thickness swelling, urea formaldehyde glue, water absorption

Introduction

Bangladesh has only 17% forest areas which are very limited compared to its demand (BSS 2011). It is therefore imperative to develop and maintain effective economical basis of utilization of forest resources especially wood and wood products. A large

amount of wood conversion is done everyday in 4,800 sawmills and wood based industries located in the different parts of the country. It has been estimated that these sawmills produce about 3.34 million tons of wood waste per year during conversion of log wood (Islam *et al*. 2004). The authors noted that sawmilling residues amount to about 40.5% of the total consumption of logs in sawmills in which edging/trimmings are 20.75%. These furniture wastage are found in different size. During processing, saw dust and planer shavings come out as wastage. Much of these waste products create problems, but efficient use of these can solve the disposal difficulties. Effective utilization of sawmill residue and wastage can lessen the problem and at the same time add to the economy of the country.

Five species namely civit (*Swintonia floribunda*), garjan (*Dipterocarpus* sp.) chapalish (*Artocarpus chaplasha*), narikeli (*Pterigota alata*) and pitali (*Trewia nudiflora*) are widely used for making particleboard in Bangladesh (Anon. 1981). Most particleboard industries use wastage of green and clipping of veneer, defaulted match sticks and round wood left after peeling veneer. But they do not use wastage of furniture industries and sawmill residue as these are of different size of shapes. Size and shape of the wood particles influence the processes and final board products (Moslemi 1974). Admixture of small particle with larger particles results in panel imbalance and thus causing strength reduction. Fine particles absorb high amount of resin for equivalent board. Oversize particles, when placed on the surface layer, produce rough surfaces. Thus uniformity of chips size is important for production of good quality board (Maloney 1977). Therefore an experiment was conducted to find out the strength properties and dimensional stability of particleboards made from furniture wastage.

Materials and Methods

Furniture wastage and planer shavings were collected from the furniture unit of Bangladesh Forest Industries Development Corporation. Garjan (*Diptrerocarpus* sp.) waste comprised 80% and the rest were teak (*Tectona grandis*) and telsur (*Hopea odorata*). The specific gravity of garjan, teak and telsur are 0.71, 0.61 and 0.64 respectively (Sattar *et al*. 1999).

The waste woods were cut into small pieces. These were hammer milled to chips using screen of 0.63 cm diameter. The chips were then sieved through 20 mesh screen to remove dust and fines. The length and thickness of chips were larger than those of planer shavings. The planer shavings were wider than the chips. The chips and planer shavings were dried in the batch oven at 70°C temperatures to 4–5% moisture content.

Fifteen single layer particleboards were prepared using the screened chips and planer shavings in the laboratory hot press. Dimension of the particleboards were 50 cm x 50 cm x 1.25 cm having a target density of 750 kg/m^3. The temperature of the platens of the hot press was maintained at 140°C. Particles of different sizes were mixed in five different ratios of wood chips and planer shaving such as 0:100, 25:75, 50:50, 75:25, and 100:0. Liquid urea formaldehyde glue having 10% solid content based on oven dry chips was used. The glue was catalyzed with 2% hardener (ammonium chloride). The mats of the board were formed manually in wooden fabricated bordered frame. The formed mats of the particleboard were pressed initially at 35 kg/cm^2 for 6 minutes. The pressure were then lowered firstly to 10.5 kg/cm^2 for 4 minutes and then 3.5 kg/cm^2 for 2 minutes and then conditioned at 65±5% relative humidity and 20±2°C temperature.

The prepared particleboards were cut into tests specimens. The static bending tests

(modulus of rupture in bending) and the tensile strength perpendicular to the surface were carried out as per IS:2380 (Anon. 1977). Thickness swelling and water absorption due to general absorption of water were done. Three specimens of size 100 mm x 100 mm were taken from each board. The thickness of the specimens was measured with the platform type thickness gauze with an accuracy of 0.01 mm and immersed in 25 mm depth of cold water at room temperature. At the end of 2 and 24 hours, the test specimens were withdrawn from water, wiped with a damp cloth, reweighed and remeasured the thickness as before. The percentage of water absorption and thickness swelling were then calculated.

Results and Discussion

Static bending and tensile strength

Results of modulus of rupture in static bending and the tensile strength perpendicular to face (IB) are presented in Table 1. The values are compared with Indian Standard IS:3087 (Anon. 1985), German Standard. Din:68761 (Verkor and Ledune 1975) and British Standard BS 5669 (Anon. 1979). It was found that the values of modulus of rupture of particle board are different for different ratios of chips and planer shavings. Particle board containing 100% planer shavings have the highest values of modulus of rupture than all other boards. The value is 143 kg/cm^2 which satisfies the Indian standard (112 kg/cm^2) and British standard (140 kg/cm^2).

High density woods are difficult to bond due to thicker cell wall, less lumen volume and higher percentage of resinous material which result less penetration of adhesive at the time of board making. In the present study, the particleboard made from only wood chips shows low modulus of rupture value compared to the standard values. This poor bonding might be due to resinous material present in the wood and low press pressure required for high density wood. Scientist pointed out that much greater pressure is required for high density wood to bring contact between wood surface and adhesive (Vick and Rowell 1990).

Table 1. Static bending strength and tensile strength of particleboard

Type of particleboard	Composition (%)		Modulus of rupture (MOR) (kg/cm^2)	Internal bond strength (IB) (kg/cm^2)
	Wood Chips	Planer Shavings		
Single layer	100	0	68	10
Single layer mixed	75	25	108	12
Single layer mixed	50	50	130	11
Single layer mixed	25	75	128	13
Single layer	0	100	143	13
IS : 3087	-	-	112	8
German Standard Din 68761	-	-	180	3.50
BS : 5669	-	-	140	3.47

The values of internal bond strength of different types of particle board are different for different ratios of chips and planer shavings. The particleboard containing 100% and 75% planer shavings shows maximum values (13 kg/cm^2) and these are higher than the standards (Anon. 1985, 1979; Verkor and Ledune 1975).

Thickness swelling and water absorption

The values of thickness swelling after 2 and 24 hours are shown in Table 2. The observed thickness swellings of the different types of boards were 5-12% after 2 hours soaking and 10-31% after 24 hours soaking. It was found that the thickness swelling of the three types of board containg 50, 75 and 100% wood chips were 11, 10 and 12% thickness swelling respectively after 2 hours soaking. These values however, do not satisfy the value specified in both Indian and German standard. The thickness swelling of the boards made of 100 and 75% planer shavings were 5 and 6% respectively after 2 hours soaking. The values satisfy in Indian and German standards. Kollman *et al.* (1975) also reported that the highest thickness swelling after two hours immersion in water should not exceed 6-10% of the original thickness.

The extent of water absorption after 2 and 24 hours soaking are given in Table 2. The observed water absorption of the different types of board was 6-17% after 2 hours soaking and 16-35% after 24 hours soaking. It was found that the water absorption after 2 and 24 hours of boards made from wood chips and planer shavings alone and in mixture satisfy the value specified in Indian standard.

Conclusion

The strength properties and the dimensional stability of particleboard made from planer shavings are found suitable and can be used as furniture components and other purposes. The increase of wood chips in mixture decreases the strength properties

Table 2. Thickness swelling and water absorption of particleboard made from furniture wastage

Type of particleboard	Composition (%)		Thickness swelling (%)		Water absorption (%)	
	Wood chips	Planner Shaving	2 hrs	24 hrs	2 hrs	24 hrs
Single layer	100	0	12	31	17	35
Single layer (mixed)	75	25	10	23	13	32
Single layer (mixed)	50	50	11	18	14	29
Single layer (mixed)	25	75	6	13	9	27
Single layer	0	100	5	10	6	16
IS : 3087			10	-	25	50
German Standard Din 68761	-	-	max -6	-	-	-
BS : 5669	-	-	2 (1hr, soaking)	-	-	-

of the board. The tensile strength perpendicular to surface was high which indicated stronger bonding for all types of board. The water absorption satisfies the different standards but the percentage of thickness swelling of some boards are high. Addition of wax emulsion with urea formaldehyde glue may improve the thickness swelling properties of the particleboards.

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