STORAGE EFFECTS OF RUBBERWOOD ON CEMENT-BONDED PARTICLEBOARD

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RAHIM SUDIN, CHEW, L.T., ONG, C.L. & ZAKARIA MOHD. AMIN. 1989. Storage effects of rubberwood on cement-bonded particleboard. Freshly felled rubberwood (*Hevea brasiliensis*), with and without bark, was stored for various periods, and examined for their carbohydrates content and cement-bonding properties. After four weeks of natural storage without bark, sugar and starch content fell below 0.5 and 7.0% respectively. A longer period up to 12 weeks was required for a similar effect when stored with bark. Boards from fresh rubberwood failed to set completely. The optimum strength of cement-bonded particleboard (CBP) produced from rubberwood stored without bark was obtained between four to eight weeks of storage while the other condition required about 12 weeks. Hence, debarking may not be necessary in large commercial production when the rubberwood is to be used after long periods of storage.

Key words: Rubberwood - storage - carbohydrates - cement-bonded particleboard

Introduction

Cement-bonded particleboard (CBP) requires a homogeneous material for consistent quality. Rubberwood, being abundant in Malaysia, meets this requirement. The total rubberwood supply in Malaysia is estimated at about 8-10 million m^3 annually from 1985 to 1990, and will increase steadily after that to over 16 million m^3 annually by 1995 (Salleh 1985).

Several studies in the past revealed that sugars available in wood has been identified as the most critical component in wood-cement board products (Schwarz & Simatupang 1984, Moslemi & Harmel 1988). For producing good quality CBP, the amount of sugars in wood should not exceed 0.6% level as stipulated by Weber (1985) and Bever (1986). In an earlier study, Azizol and Rahim (1989) determined that fresh rubberwood contains about 1.1 to 2.3% of total free sugars and 7.5 to 10.2% starch along the height and diameter of the tree.

Freshly felled trees normally contain higher amounts of carbohydrates which inhibit cement setting in CBP manufacture. Logs are stored in the open between two to four months to ensure the equalisation of the wood moisture content and the degradation of cement anti-reactants especially sugars in the logs. Schwarz and Simatupang (1984) reported that the sugar content of temperate pine was reduced to 0.1 and 0.2% when stored in the open and under shade respectively. It is believed that fungi and microorganisms present in the wood use the carbohydrates as food, thus lowering the carbohydrate content during the storage period (Norhara 1981, Hong 1982).

We examine the properties of CBP manufactured from rubberwood logs stored with and without bark in the open and also attempt to identify the optimum storage time to produce good quality CBP.

Materials and methods

Rubberwood

Fifteen 36-years old rubber trees were selected from the Bukit Kiara rubber plantation in Kuala Lumpur, Peninsular Malaysia. The trees' diameters ranged from 19 to 24 *cm* at breast height. Most of the trees had straight boles and few leaves as the trees were felled during the dry season. Each tree was cut into six 1 *m* long billets, starting 20 *cm* from the ground and separated evenly into three groups for: (a) storage without bark; (b) storage with bark; and (c) determination of starch and sugar contents at different positions and heights of the trees.

Storage with and without bark

Six billets were taken from each tree, with the bottom billet marked as number 1 and the topmost billet marked as number 6. All the billets, with and without bark, were then stored in the open. After two weeks, number 1 billet from all the trees were processed for the manufacture of CBP and the determination of the sugar and starch contents simultaneously. Billets 2 to 6 were similarly processed after 4, 8, 12, 16 and 20 weeks of storage respectively.

Manufacture of CBP

For this study, ten bags of fresh Portland cement manufactured by Associated Pan Malaysia Cement, Rawang, Peninsular Malaysia, were used. The chemical constituents and physical properties of the cement comply with the requirements of MS 522: Part 1 (1977) for Portland cement (Ordinary and Rapid Hardening).

The rubberwood samples were cut with a guillotine into discs of thickness 2.5 *cm* before being processed into chips of dimensions 25 x 25 x 5 *mm*. Further processing into smaller particles was done with Pallmann knife ring flaker. The particles were then screened for fines less than 2 *mm* thick and coarse materials of 2 *mm* and above for the CBP.

In the CBP manufacture, the wood : cement ratio was set at 1 : 2.4, based on oven dry weight. Mineralising chemicals, namely aluminium sulphate and sodium silicate, at 2% by weight of the cement, were added as cement accelerators to the wood-cement mixtures. The moisture content of the mixtures was maintained at 45%. The CBP were of dimensions 300 x 300 x 8.6 *mm* with a density of 1250 $kg\ m^{-3}$. A total of five panels were made from each condition and five specimens from each panel were tested for bending strength, ten specimens for tensile strength and four specimens for water absorption and thickness swelling, respectively. The boards were evaluated according to Malaysian Standard MS 934 (Anonymous 1984).

Results and discussion

Fresh rubberwood was found to contain 1.05 to 2.29% of total sugars and 7.30 to 10.17% starch based on analysis carried out on five trees at six height levels (Azizol & Rahim 1989). When the rubberwood was stored in the open, either with or without bark, sugar and starch contents dropped significantly (Table 1).

Table 1. Sugar and starch contents in rubberwood logs with and without bark at different periods of storage

Period of storage (weeks)	Storage			
	With bark		Without bark	
	Sugar (%)	Starch (%)	Sugar (%)	Starch (%)
0	1.702	8.84	1.702	8.84
2	0.924	9.24	0.849	7.87
4	0.979	8.97	0.395	6.76
8	0.722	6.65	0.379	3.46
12	0.620	2.01	0.415	2.70
16	0.433	1.03	0.530	2.01
20	0.230	1.08	0.287	1.90

The sugars and starch contents in rubberwood logs stored without bark dropped faster than those with bark in the first 12 weeks (Table 1). When stored without bark, the sugar content dropped to below 0.6% in four weeks, but it took 16 weeks for the samples with bark to reach similar levels. The reduction of starch was quite rapid in the first 12 weeks of storage without bark and first 16 weeks with bark. The sugar and starch contents remained practically constant after these periods, the 'open-window' for CBP production (Moslemi & Harmel 1988).

Several series of CBP were produced from the fresh and stored rubberwood in order to determine the correlation between the sugar and starch contents and the strength properties of the cement-bonded particleboard produced. CBP manufactured from fresh rubberwood failed to set and could not be evaluated (Table 2). This is due to the high levels of sugar and starch in fresh rubberwood which inhibit cement curing. These organic cement inhibitors contain hydroxyl groups (H-C-OH) which are absorbed by cement surfaces and retard the absorption rate of H_3O^+ ions on the cement mineral surfaces and slow down the setting reaction (Hansen 1952).

Table 2. The physical properties of CBP from rubberwood storage under different conditions

Sample Number	Period of storage (weeks)	Bending strength (*MPa*) n = 20	Tensile strength (*MPa*) n = 50	Water absorbtion (%) n = 15	Thickness swelling (%) n = 15
Fresh	0	0	0	-	-
B 2	2	3.14 (0.49)	0.06 (0.02)	32.5 (3.82)	3.63 (1.33)
B 4	4	3.01 (0.24)	0.10 (0.02)	28.2 (2.15)	1.82 (0.47)
B 8	8	8.28 (1.16)	0.55 (0.17)	21.3 (1.86)	0.85 (0.19)
B 12	12	12.30 (1.55)	1.23 (0.20)	21.8 (1.55)	0.85 (0.22)
B 16	16	11.48 (1.14)	0.85 (0.20)	17.0 (2.30)	0.70 (0.22)
B 20	20	11.49 (1.31)	1.09 (0.30)	16.3 (2.53)	0.58 (0.14)
WB 2	2	4.63 (0.56)	0.17 (0.05)	32.8 (1.31)	3.32 (0.64)
WB 4	4	10.17 (0.96)	0.74 (0.20)	16.8 (1.92)	0.63 (0.28)
WB 8	8	10.55 (1.60)	0.96 (0.16)	17.5 (2.21)	0.44 (0.23)
WB 12	12	9.47 (1.66)	0.99 (0.30)	18.6 (1.06)	1.12 (1.28)
WB 16	16	9.17 (1.50)	0.98 (0.20)	21.7 (2.31)	1.04 (0.32)
WB 20	20	9.34 (1.08)	0.97 (0.29)	21.6 (2.05)	0.58 (0.15)
MS 934: 1986		9.00	0.50	NA	2.00

Keys: B - rubberwood stored with bark
WB - rubberwood stored without bark
NA - data not available
Figures in parentheses denote standard deviation

The bending strength of CBP manufactured from rubberwood stored without bark increased and attained maximum value at four to eight weeks of storage (Table 2) while that stored with bark attained maximum value at 12 weeks. Further, CBP produced from rubberwood stored with bark gave slightly higher bending strength values after nine weeks of storage and followed a similar trend thereafter. This is probably due to the rubberwood stored with bark being less exposed to natural degradation and wood decay. Decayed wood considerably lowers the strength properties of CBP (Weatherwax & Tarkow 1967).

The tensile strength of CBP manufactured from rubberwood stored without bark increased and attained maximum strength at eight weeks of storage, while CBP from rubberwood stored with bark increased and attained maximum tensile strength at 12 weeks of storage (Table 2). In general, CBP produced from rubberwood stored without bark gave better strength properties, particularly after the first eight weeks of storage.

The water absorption rates declined gradually with increasing storage time for CBP manufactured from rubberwood stored with bark (Table 2). The thickness swelling of both CBPs was reduced to below 2% after only four weeks of storage and remained at that low level thereafter.

Application

Rubberwood logs for the manufacture of cement-bonded particleboard with optimum strength properties should be stored without bark in the open and used within two months after felling. If the logs are to be used later, they should be stored with bark which may provide some protection against wood decay. Better board properties were produced from rubberwood containing sugar content less than 0.6%. A direct correlation is seen between the strength properties of CBP produced from and the level of sugars available in each batch of rubberwood.

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