PARTICLEBOARD PROPERTIES FROM MAHANG GAJAH (Macarranga gigantea) PARTICLES

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Abstract

The objective of the study was to evaluate the properties of particleboard produced from Macaranga gigantea and to study the effect of board density variation and wax content on particleboard properties. Mahang wood density was found to be in the range of 351.35 kg m^{-3} to 354.92 kg m^{-3}. The result for bulk density for admxiture of trunk and branch of Mahang particles was 75.75 g/l. Particleboard with density of 650 kg/m^3 gave the highest mechanical properties for both boards with 0% and 1% wax content. The MOR, MOE and IB were shown to increased with higher density. Boards with 1% wax addition showed lower mechanical properties. For physical properties, that is thickness swelling gives same trend like mechanical properties. For water absorption, the result decreases with the increase of board density. All boards failed to meet the minimum requirements of the BS EN Standards.

Keywords: *particleboard, mahang gajah, resin content, wax content*

INTRODUCTION

Particleboard is a wood based panel product produced by compressing small particle of wood while simultaneously bonding them with an adhesive. Miller (1977) reported that by altering the processing variable such as species, particle geometry, resin level, moisture content, board density and pressing cycle (pressure and press time) the board properties may be affected.

Particleboard is a wood panel product used widely in the manufacture of furniture, floor underlayment, home constructions, cabinets, stair treads, shelving, table tops, vanities, speakers, sliding doors, lock blocks, interior signs, displays, table tennis, pool tables, electronic game consoles, and others. Panels can be made in variety of sizes and specific gravity, thus providing great opportunity to design ultimate products with a specific particleboard panel needed. The particles come primarily from planer shavings, edgings, sawdust, and other process residuals. The properties of particleboard that have the greatest influence on its selection for a use are its uniform smooth surface and its ability to stay flat (Nemli & Kalaycıog˘lu, 2005).

In the early 1980's the rich forest resources have enabled Malaysia to become one of the world major producers and suppliers of tropical timber and timber-based products. However, at present there are a lot of uncertainties in the supply of raw materials for the wood-based industries but the demand for their products is still increasing. According to Choh and Poh (1993) the rapid economic growth experienced by Malaysia during the 1970 to 1990' has accelerated the depletion of the country's forest resources. Similarly, the rapid growth of the wood-based industry that contributed significantly to the rapid economic growth also induced undesirably fast exploitation of the forests. These have resulted in poorly stocked logged-over forests that are slow to recover, which is the main reason for log supply shortages that are already felt in Peninsular Malaysia.

The lesser known species of Macaranga (Euphorbiaceae) grows very fast and form a major component of the secondary forest flora of South East Asia (Davies, 1998). Macaranga gigantea or its local name Mahang gajah is a species from the family Euphorbiaceae. This species of tree can be classified as Light Hardwood and the distribution of Mahang tree are found in lowland forests and it is reported to be non-durable and have an air-dry density of 270 - 495 kg/m^3 (MTC, 2002). The objectives of the study were to evaluate the properties of particleboard produced from Macaranga gigantea and to study the effect of board density variation and wax content on particleboard properties.

MATERIALS AND METHODS

Field Procedure and Material Preparation

Mahang tree were harvested from UiTM Pahang Forest Reserve in Jengka. Two trees with a diameter at breast height of 15 cm and 25 cm were felled and then cross cut into 8 feet bolts. The logs were then sawn lengthwise into smaller planks of about 1" x 1" x log length. The big branches were also used and they were also cut into smaller sizes for the chipping process. After chip production they were then passed through a knife ring flaker to obtain smaller particles. The particles were then air dried for a week and then oven dried at 80 C for 24 hours to reduce the moisture content to less than 5%.

Bulk Density and Particle Analysis

In the determination of bulk density a 1 liter cylinder was used, where particles are dropped from a suitable height into the cyclinder and the weight of the particles is then recorded as the bulk density (g/l). Particle analysis was conducted using sieve shaker machine. Approximately 100 g of wood particle were placed in the top sieve, then machine was operated for about 20 minute. The weight for each sieve was then recorded. The size of the sieve was 500 micron, 355 micron, 250 micron, 125 micron and 75 micron.

Particle Geometry

According to Miller (1977), the ideal particle for developing strength and dimensional stability is a thin flake of uniform thickness with a high length to thickness ratio. Particle geometry was conducted on 100 particles at random where the measurement of length and thickness were recorded.

Manufacture of Particleboard

Single layer urea formaldehyde particleboard of 12 mm thickness at varying board density (450, 550 and 650 kgm^{-3}) and wax content of 1 % were produced. Unscreened particles were used and resin content was maintained at 12 %. In the manufacture of particleboard, a measured quantity of particles was sprayed in glue mixer with the resin and wax. The sprayed particles were then laid in a wooden mould and pre-pressed at 3.5 kgcm^{-2}. The consolidated mat was finally pressed in Taihei hot-press at 165°C for 6 minutes. The cooled board was then conditioned in a condition room at 20°C and 65% relative humidity. The board was then cut into the desired sizes according to the BS EN 326-1 (1994) and test for bending and modulus of elasticity, and internal bond (BS EN 310 & 319, 1993) and dimensional stability tests (BS EN 317, 1993).

RESULTS AND DISCUSSION

Wood and Particle Properties

The density of macarangga wood was found to be in the range of 351.35 kg m^{-3} to 354.92 kg m^{-3}. The result for bulk density for mix trunk and branch of Mahang particle was found to be 75.75 g/l. Higher bulk density means higher weight of particles and less volume required. As a result, particleboard is easy to form during pressing and less spring back. Table 1 shows the result of sieve shaker test for mix trunk and branch of Mahang particles. From this analysis, the majority sizes of particle involved in this particleboard making is above 355 micron and suitable for particleboard making.

Mechanical and Physical Properties

Table 2 shows that the mean value for MOR, MOE, IB, TS and WA. Particleboard made at a target density of 450 kgm^{-3} without wax addition had the worst WA of 119.93%. While particlebooard made a target density of 450 kgm^{-3} with 1% wax addition had the lowest MOR (7.99 MPa), IB (2.09 MPa), however it showed the lowest value for TS of 16.67%. Meanwhile particleboards made at a target density of 550 kg m^{-3} without wax addition had better MOR (13.32 MPa) and IB (2.59MPa) values compared with boards with wax addition. However boards with wax addition had better WA (74.30%) and TS (24.02%) values. The board with density of 650 kg/m^3 without wax addition showed the highest MOR value 25.43 MPa. It also had higher MOE (3351 MPa) and IB (4.63 MPa) values than boards with 1 % wax addition. Board containing high amount of particles increases the particle bonding and the higher compaction ratio increases the board properties. Kelemwork et al. (2007), Jamaludin et al (2010) and San et al. (2010) also reported similar relationship between board density and mechanical properties. Less water can absorb into high-density board due to better compaction of the particles during pressing creating fewer gaps between particles. Xu et al. (2009) also confirmed better WA and TS value with wax addition.

All boards showed increasing MOR values with higher board density but failed to meet the minimum value of 14.00 MPa. Boards with 1% wax addition showed lower mechanical properties. For physical properties, thickness swelling gives same trend like mechanical properties. For water absorption, the WA result improves with the increase of board density. However, all boards failed to meet the minimum requirements of the BS EN Standards.

Table 1: Particle Analysis of Mahang Particles

Size (micron)	%
> 355	73.96
250	9.75
125	11.88
75	2.75
Fines	1.21

Particle Length	1.00 cm
Particle thickness	0.56 cm
Slenderness ratio	179

Table 2: Mechanical and Physical Properties of Particleboard

Density (kg/m^3)	WAX (%)	MOR (MPa)	MOE (MPa)	IB (MPa)	TS (%)	WA (%)
450	0	9.27	1385.75	3.08	19.38	119.93
550	0	13.32	2017.64	2.90	24.87	105.90
650	0	25.43	3350.73	4.63	30.88	66.27
450	1	7.99	1351.80	2.09	16.67	79.07
550	1	11.99	2145.13	2.59	24.02	74.30
650	1	18.62	2999.99	3.26	23.29	61.70
BS EN		14.00	2000	5.0	12.00	n.a

CONCLUSION AND RECOMMENDATION

Increasing the density of board increases the board strength and stability. The presence of wax affected the mechanical properties but improves the physical properties of board. All boards failed to meet the minimum value of 14.00 MPa. For physical properties, thickness swelling gives same trend like mechanical properties. For water absorption, the result decreases with the increase of board density. All boards failed to meet the minimum requirements of the BS EN Standards. It can be recommended that if the particles of mahang are to be use as raw materials in the manufacture of particleboard, further studies on its performance must be conducted first.

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