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JILID 1

OIL PALM SHELL KERNEL IN CEMENT BOARD (OPSCB)

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ABSTRACT :

A wide variety of agricultural by-products are presently used, or is potentially usable in construction. Such by-product from the agricultural industry, oil-palm plantation being one of them, include palm shell kernel, empty fruit bunches, pressed fruit fibres, and frond. However it has been reported that these by-products are being hauled away as solid waste to landfills. Growing scarcity of dumping sites and coupled with stricter regulations of dumping practices have led to the use of a substantial proportion of these by-products in construction. In an attempts to exploit the benefits of waste solid management via recycling and reusing of solid waste, an experimental programme was established to look into the prospect of incorporating ground oil-palm shells as 'aggregates' into cement-based composites. Cement-bonded particle boards were prepared and tested to BS 5669. Variations in the mixes were the the total water content and the 'aggregate - to - cement ratio. Preliminary studies revealed figures in the range of 2.9 o 6.3 Mpa are obtainable for the bending strength (or. Modulus of Rupture) of the boards with the total water content of between 35 to 45 percent of the total weight of dry materials and the 'aggregate'-to-cement ratio of between 1:2.5 to 1:3.5. Dimensional stability of the boards was also reported.

Keyword: Agricultural by-products, Oil Palm Shell and Cement-bonded particle boards.

INTRODUCTION

Oil palm was first introduced into Malaysia in 1870 through the Botanic Gardens in Singapore. Initial interest was in the ornamental value of the palm but by early 1900, interest in the commercial exploitation of the palm began to develop. However the industry initially slow but the situation changed in the early 1960's when the rubber prices fall (Moll, 1987). To date more than 60,000 tonnes of palm kernel cake (PKC) are produced annually. Such production has led Malaysia be the world's leading producer and exporter of palm oil and palm oil products. Recent report shows that mesocarp fibres and shell are used as fuel to boil water to produce steam that in turn generates electricity and empty fruit bunches incinerated to produce ashes to be distributed back to the field as fertilizer. It is also reported that these residues are usually burned in a conventional way and creates environmental problems of severe air pollution.

Cement-and gypsum-bonded particleboards using ground treated and untreated oil-palm stems and fronds have been the subjects of research at the Forest Research Institute of Malaysia or FRIM in Kepong over the last 20 years. Problems associated with the presence of sugar and starch contents contents were elaborated and those recommendations put forward by Schwarz (1989) were adhered to. Rahim et al. (1990) conducted a series of experiments on single-layer and three-layer particleboards using ground wood flakes and chips. Bending strengths of up to 9.3 MPa have been obtained from boards produced with a 'wood aggregates'-to-cement ratio of 1:3.5 and water content of 30%. Variations in the board performance were also discussed with respect to the conditioning of the 'wood aggregates'.

MATERIALS AND METHODS

Materials

Cement

The Ordinary Portland Cement (OPC) from a single source was used throughout the study.

ii) Palm shell particles

The shells were obtained from Meru Palm Oil Factory in Meru, Kelang. They were dried under the sun for two days to remove any leftover flesh/oil from the kernels. They were then reduced in size manually using a crusher to the size of sand. The reduced-size-shells were then subjected to a series of grinding cycles, producing particles in the range between 0.5 to 2.0 mm. The resulting particles were later screened into four different sizes via 2.00 mm, 1.00 – 2.00 mm, 0.5 – 1.0 mm and less than 0.5 mm sieve sizes, and those particles between 1.00 to 0.5 mm were used in the production of laboratory-prepared cement-bonded particleboards.

Board Preparation

Nine different formulations with three different ratios of 'aggregate'-to-cement namely 1:2.5, 1:3.0, and 1:3.5 and three different water contents namely 35%, 40% and 45% for each ratio, were investigated. The boards were prepared with a dimension of 500 mm x 500 mm x 10 mm. The cement and particles were manually mixed and then poured into a mould of the same size. They were pressed in a hot-press machine by applying a pressure of 50 psi in the first 15 minutes, 100 psi in the subsequent 15 minutes, and finally 300 psi in the remaining 30 minutes. The boards were then demoulded and cured under water for 28 days before being cut into appropriate test specimen sizes.

Methods of Testing

The performance of the particleboards with ground oil-palm shells was assessed by evaluating the bending strength, density, water absorption and swelling. The preparation of test pieces and the procedures for testing of the test pieces for the relevant properties were in accordance with BS 5669: Part 1: 1989.

RESULTS AND DISCUSSION

The bending strengths, f, and the densities, λ, of the boards from the series of nine formulations are shown in Table 1. The former is compared with those given in BS 5669: Part 4: 1989 for either Type 1 or Type 2 boards. The mean bending strength for a production quality level, specified in Table 1 of the standard is 10 MPa, and that none of the test pieces from the series of nine boards tested has achieved such a strength level. The boards prepared from the 'aggregate'-to-cement ratio of 1:3, with a water content of 45% of the total dry weight of the materials used however recorded the highest bending strength, ranging from 6.0 to 6.3 MPa or a mean value of 6.1 MPa. The present limited study reveals to a certain extent the possibility of the ratio 1:3 being the optimum so that increasing or lowering of the cement content would result in a negative impact on the bending performance of the boards. It is interesting to note the significance of adding more water in the 'aggregate'-cement composites. In all cases, increasing the amount of water added to the mixes results in an increase in the bending strength of the boards, possibly attributed to the ease of compaction of the 'aggregates' or particles within the mixes during pressing. Generally, the higher degree of compaction achievable for a particular mix results in boards of higher density, and to a lesser extent, bending strength.

Differences in thickness (or, swelling) and mass (or, water absorption) of the boards due to a general absorption of water are given in Figures 1 and 2, respectively. Measurements were taken before immersion in water and thereafter, every 24 hours of immersion, ups to 96 hours. Table 2 summarizes the water absorption O_1 and the swelling λ_1, after 1 hour of immersion and O_{24} and λ_{24}, after 24 hours of immersion. The water absorption of the boards reduces as the cement content increases. In other words, the resistance of the cement-'aggregate' composites to water uptake improves with the quality of the binder or matrix.

Monitoring the water absorption of the boards until 96 hours of immersion reveals a plateau of weight change after about 48 hours, except for those boards that were prepared from the 'aggregate'-to-cement ratio of 1:2.5, which continue to absorb water at an increasing rate. Positive changes in the thickness (or, swelling) of the test pieces are only consistently observed on test pieces cut from the boards with the 'aggregate'-to-cement ratio of 1:2.5. Other boards recorded negative changes that could artificially indicate a contraction. Recognizing the possibility of wearing out of the boards at points of reference on the test pieces where measurements were taken, the negative changes in the thickness of the specimens are ignored, and thus considered invalid and did not indicate contraction. Swelling generally reduces to zero after about 24 hours of immersion in water.

Table 1 Bending Strengths and Densities of Nine Series of Cement-Bonded Particleboards using Ground Oil-Palm Shells

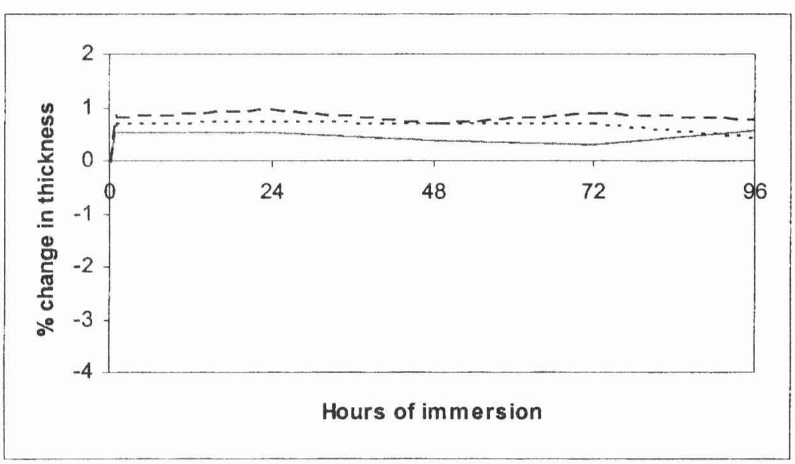
'Aggregate'-to-cement ratio	Water content (%)	Density (kg/m^3)	f (MPa)
1 : 2.5	35	1501	3.0
	40	1561	3.4
	45	1664	4.3
1 : 3.0	35	1604	4.3
	40	1592	5.2
	45	1649	6.1
1 : 3.5	35	1766	3.6
	40	1731	4.6
	45	1815	5.6

Table 2 Water Absorption and Swelling of Nine Series of Cement-Bonded Particleboards using Ground Oil-Palm Shells

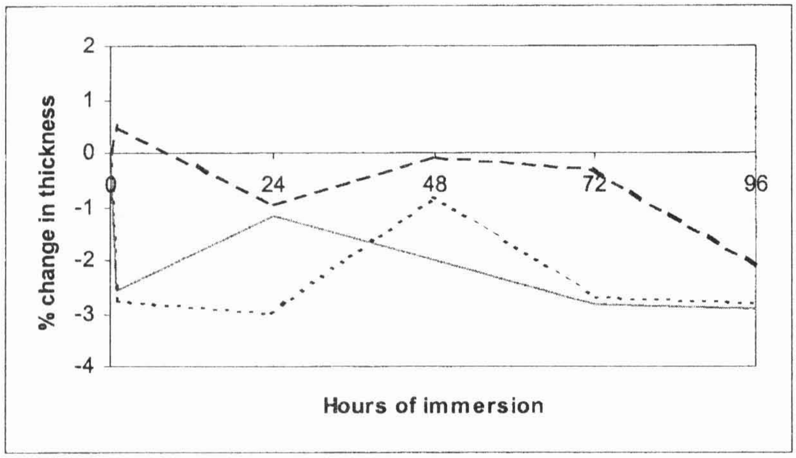
'Aggregate'-to-cement ratio	Water content (%)	O_1	O_{24}	λ_1	λ_{24}
1 : 2.5	35	2.2	4.1	0.7	0.7
	40	2.4	4.8	0.5	0.5
	45	2.5	4.9	0.8	1.0
1 : 3.0	35	1.3	2.5	-2.8	-3.0
	40	1.8	3.3	-2.6	-1.2
	45	1.8	2.7	0.5	-1.0
1 : 3.5	35	0.8	1.4	-0.4	-1.4
	40	0.8	1.6	0.0	-0.4
	45	1.0	1.7	0.2	-0.1

Note: Negative swellings λ are considered invalid, and taken as zero.

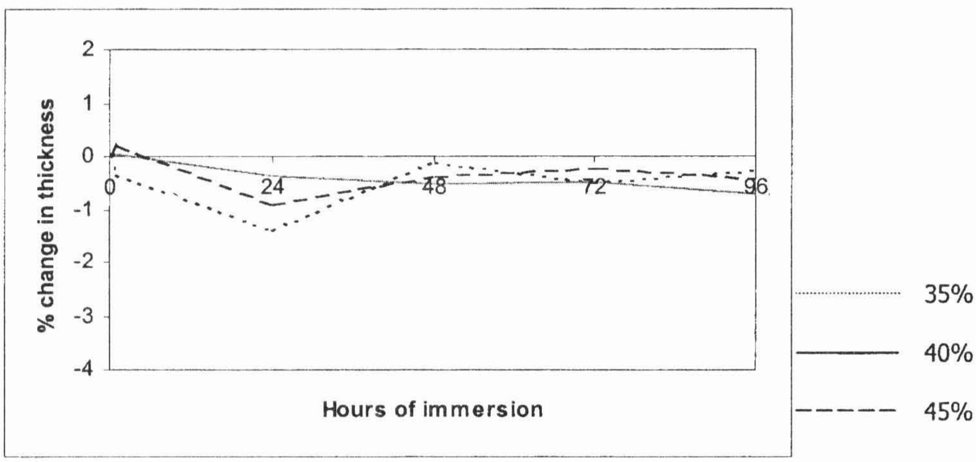
Figure 1 (a-c) Swelling of Cement-Bonded Particleboards using Ground Oil-Palm Shells



(a) 'aggregate'-to-cement ratio of 1:2.5

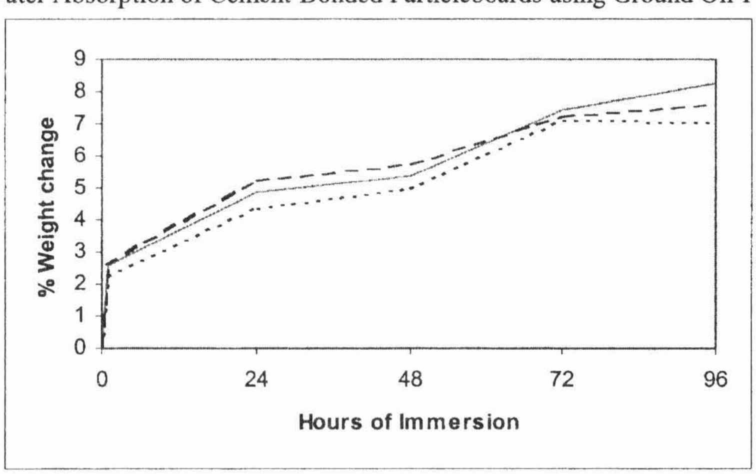


(b) 'aggregate'-to-cement ratio of 1:3.0

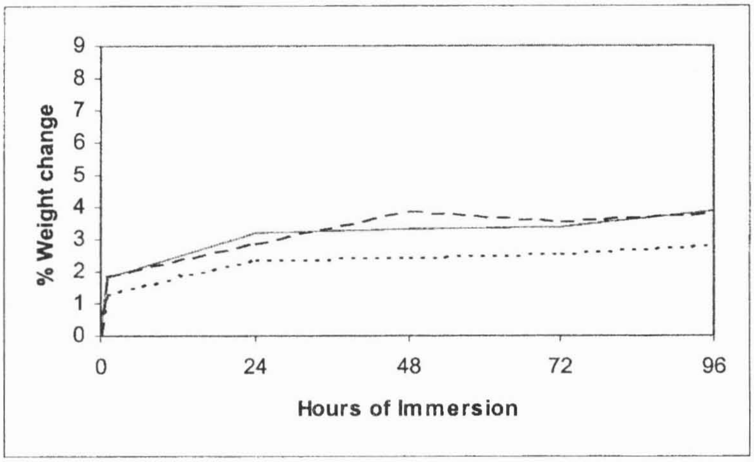


(c) 'aggregate'-to-cement ratio of 1:3.5

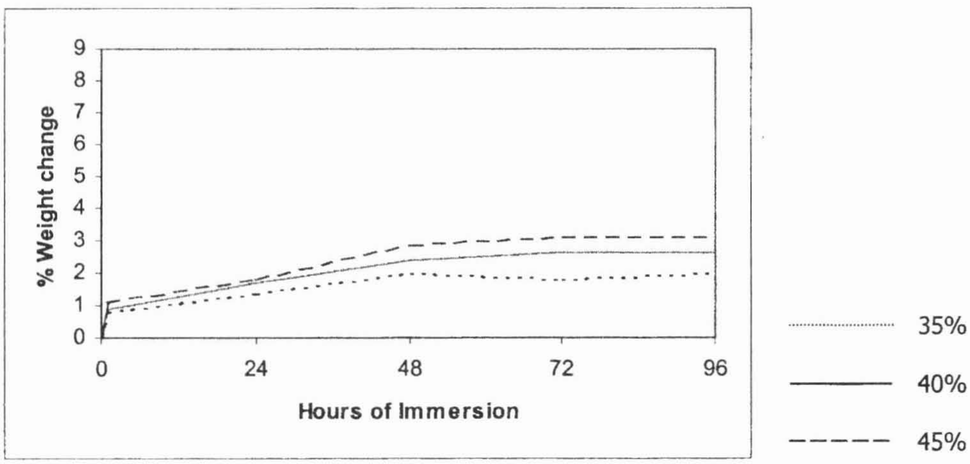
Figure 2 (a-c) Water Absorption of Cement-Bonded Particleboards using Ground Oil-Palm Shells



(a) 'aggregate'-to-cement ratio of 1:2.5



(b) 'aggregate'-to-cement ratio of 1:3.0



(c) 'aggregate'-to-cement ratio of 1:3.5

CONCLUSIONS

A series of nine cement-bonded particleboards was prepared from three different 'aggregate'-to-cement ratios and three different amounts of water added during mixing. These varying parameters have been shown to significantly influence both the physical and mechanical properties of the boards. A bending strength, f, of up to 6.3 MPa (or, a mean value of 6.1 MPa) has been recorded from boards having an 'aggregate'-to-cement ratio of 1:3 and water content of 45%. The water absorption, O_1, and swelling, λ_1, of the corresponding test pieces are 1.8 and 0.5, respectively. Generally, boards produced using a higher cement content than those with an 'aggregate'-to-cement ratio of 1:2.5 exhibit zero swelling, a characteristic established assuming invalid negative differences. It should be emphasized that possibilities of treating the particles and/or autoclaving or temperature curing of the boards are underway.

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REFERENCES

1. Moll, H.A.J.1987. The Economics of Oil Palm. Economics of Crops In Developing Countries No.2. Pudoc Wageningen, Netherlands.
2. Rahim Sudin and Khoizirah Shaari (1990). Cement –bonded particleboard from oil palm stem – effect of chip/flake storage under shade and under water on board properties. (draft report)
3. Schwarz, H.G. (1989). Cement-bonded boards in Malaysia. Proceedings of the Fiber and Particleboards bonded with inorganic binders. Forest Products Research Soc., Usa:91-3.
4. BS 5669: Part 1: 1989, Methods of Sampling, Conditioning and Test for Particleboards
5. BS 5669: Part 4: 1989, Specifications for Cement Bonded Particleboards