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Production and Test of Mechanical Properties of Ceiling Board Produced From Local Waste Materials

(SAW DUST, WASTE PAPER AND PALM KERNEL CHAFF)

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ABSTRACT
This paper presents the production and the test of the mechanical properties of ceiling board produced from local waste materials (saw dust, waste paper and palm kernel shaft) for sustainable use of raw materials in finding good substitute which have good tensile strength and poor heat conductivity was developed. Reuse of waste materials to produce new and useful ceiling board was done in the laboratory. The following tests were performed on the produced ceiling board. Water absorption, flexural strength and flaking strength. The results for water absorption obtained were 20.3% of the dry sample, flexural 0.02Nmm^2 to 0.03Nmm^2 with the mean of 0.030N/mm^2 flaking strength and 6.18×10^{-3} to $6{,}54 \times 10^{-3}$ with an average of 6.30×10^{-3}respectively. The compressive strength was equally tested and the result was 1.29kpa to 1.88kpa. The work shows good potentials of ceiling board from local waste materials when compared to the industrially made ceiling board.

Key words: Ceiling board, sawdust, Palm Kernel chaff, waste paper,Water absorption,flexural strength and flaking strength.

I. INTRODUCTION

A ceiling board is a horizontal slab covering the upper section of a room or internal space. It is generally not structural but it is a shell concealing the details of the above. However, it may be holding up building materials such as heat or sound insulation (Isheni, 2017). Ceiling boards are grouped in accordance with the type of raw materials used in the production. These includes: gypsum fibre ceiling boards, acoustical ceiling boards, cement fibre ceiling boards, gypsum ceiling boards etc. (Achema, 2017).

Several studies on the use of agricultural waste for production of ceiling board have been reported. (Oban, 2012) produced ceiling boards using saw dust, waste paper and starch. This was aimed at to produce alternative ceiling boards to traditional asbestos ceiling boards that pose threat to human health, and also being expensive. A laboratory experimental procedures were used to determine the production of the composition. This procedure subjected the produced ceiling boards to test such as thermal conductivity test which had an average of 9.2×10^{-2}w/mk, flexural strength of $0.05\mathrm{N/mm^2}$, flakiness test $6.8 \times 10^{-3}\ \mathrm{N/mm^2}$. The production of ceiling boards from agricultural waste such as saw dust, rice husk and maize husk aimed at eliminating or reducing agricultural waste, used of asbestos ceiling boards and to effectively minimizing the high cost of asbestos was done by (Yahaya et al., 2017). The composite ceiling boards were produced and subjected to thermal conductivity test, water absorption test, flexural test, modulus of elasticity and density in accordance with ASTM and British standards. Results were obtained for water absorption properties, thermal conductivity, flexural strength, density of composite material as; 12.30% to 23.35%, 0.098 to 0.065, $0.1\mathrm{N/mm^2}$, and $103\mathrm{kg/m^3}$ and $190\mathrm{kg/m^3}$ respectively.

This work therefore, is based on how these natural fibres, waste papers and saw dust can be used in the production of ceiling boards, in order to reduce cost, reduce the use of asbestos, its effects on human health.

II. MATERIALS AND METHOD

2.1 Sample Collection

Waste papers, were collected from Petroleum Training Institute, Effurun and sawdust,

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cardboard, palm kernel chaff, cement, gypsum and starch were obtained from the market.

2.2 Preparation of Sample

One kilogram (1kg) of waste paper and cardboard were cut into sizeable pieces and soaked for one hour and was then mashed using pestle and mortar until appeared smooth. 1kg of palm kernel chaff was dried and grinded to the least grain size and placed in a sample bow. 1kg of sawdust was also dried and grinded to the least grain size. Cement was prepared by mixing with water, dried starch was prepared using hot water with continuous stirring to mix properly until it becomes sticky.

2.3 Production Process

The prepared sticky sample was placed in a metallic mould of 2mm x 300nm and was lightly oiled with petroleum lubricant. The mixture was then casted on the mould by manual compaction. A trowel was used to smoothen the exposed surface and was sundry in an open air for some time. The cast was then removed from the mould after it was observed that it was properly dried and has gained enough strength.

The same process above was repeated for the production of Sawdust and palm kernel chaff ceiling boards.

2.4 Tests Carried Out on the Ceiling Board Samples

2.4.1 Water Absorption:

All samples were weighed before and after soaking in water and noted as W_2 and W_1respectively. Water absorption is given as:

$$W.A = \frac{W_2 - W_1}{W_1} \times 100$$

Where WA = water absorption
W_2 = final weight
W_1 = initial weight

2.4.2 Flaking Test:

The dried board sample was weighed (W_1) and hard brush was used to rub the two surfaces of the sample board. 50 strokes of forward and backward movements were made against the surfaces. The flaked particles from the surfaces were collected and weighed. The flaked board was also weighed (W_2). The same procedure was repeated for nine (9) more samples. Flaking concentration (Fc) is given as

$$F_c = \frac{W_1 - W_2}{W_1}$$

2.4.3 Flexural Strength:

The composite was casted to size 100x100x500 mm of the sample beam. The hardened samples were subjected to flexural (BENDING) stress. Flexural stress is given as:

$$F = \frac{PI}{bd^2}$$

where:
F is flexural strength
P is the maximum load on the beam
I is the span of beam
b is the width of the beam
d is the depth of the beam

2.4.5 Compressive Strength:

this was done using Instron 4250 universal testing machine in the mechanical laboratory.

RESULT AND DISCUSSION

Table 1: Water Absorption Test of Board Samples

Sample No.	Sample board	Dry weight of sample (kg)	Weight of surface wet sample (kg)	Percentage water absorption (%)
1	Waste paper	1.40	1.79	28.0
2	Palm kernel chaff	1.30	1.44	11.0
3	Sawdust	1.20	1.60	33.0
5	Waste paper + palm kernel chaff	1.60	1.90	19.0
6	Sawdust + palm kernel chaff	1.50	1.83	22.0

7	Waste paper + sawdust + palm kernel chaff	1.89	1.96	4.0

III. RESULTS AND DISCUSSION

Table 1-4 showed the various test performed on the materials used as well as the various composite materials produced. In the following mix: water t palm kernel chaff, saw dust t palm kernel chaff.

Fig. 1-4 were also used to illustrate the result pictorially.

In table 1. The waste pater + sawdust + palm kernel chaff.

Gave the least percentage water absorption of 46 while, sawdust+ palm kernel chalff showed 22% water absorption. These results where to be compound with similarwork done earlier by Yakub et al., 2017 they reported water absorption of 15.8%. the waste paper + sawdust + palm kernel chaff composite this work should improvement of about 400% above their result.

In tables 2 and 3 the flaking and flexuaral strength tests for the three composites were almost the same values, (6.25-6.30) N/mm^2 and 0.003 N/mm^2 respectively these results compares favourably with the similar test on ceiling bound from composite Agricultural wastes materials by Sylvester 2012. In table 4 the compressible strength test result were presented the waste paper + palm kernel chaff gave the highest valve of 1.88kpa. The sawdust + palmkernel chaff gave 1.49kpa. However, if these compressible strength results is compound to the work of Ekpunobi 2015 have shown that the

The production of ceiling board using waste materials like waste pater + sawdust palm kernel chaff have shown to be of good composite materials for ceiling board production.
Compressible strength of produced ceiling board from waste materials ranged from 2.0-6.0 which is quite higher from this waste.

IV. CONCLUSION

This work has shown that wastes materials (agricultural or domestic) can be put into a sustainable use as a raw material to produce useful and economic materials. The waste materials used in this paper were waste paper, palm kernel chaff and sawdust. The wastes materials were produced in there composite materials; waste paper + sawdust, waste paper + palm kernel chaff respectively. Laboratory test were performed of the ceiling bound materials like water absorption flake strength, flexurial strength and compressible strength. From the various tests. The waste paper + sawdust + palm kernel combination gave the best favourable result to be use as ceiling board.

Table 2: Flaking Test of the Boards

Sample No.	Sample Board	Dry Weight of Sample (W_1) (g)	Weight of Flake Sample (W_2) (g)	Weight flake Sampl when Wet (W3) (g)	Flaking Strength Fe($x10^{-3}$)Nmm^2
1	Waste paper	1.400	0.90	13.910	6.42
2	Palm kernel chaff	1.300	0.85	129.15	6.54
3	Sawdust	1.200	0.80	119.20	6.67
4	Waste paper + sawdust	1.700	1.05	168.95	6.18
5	Waste paper + palm kernel chaff	1.600	1.00	159.00	6.25
6	Sawdust + palm kernel chaff	1.500	0.95	149.05	6.33
7	Waste paper + sawdust + palm kernel chaff	1.890	1.19	187.81	6.30

Table 3: Flexural Strength Test

Sample No.	Sample Board	Maximum Load (N)	Flexural stress (N/mm^2)
1	Waste paper	39.25	0.020
2	Palm kernel chaff	49.05	0.025
3	Sawdust	41.20	0.020
4	Waste paper + sawdust	54.45	0.025
5	Waste paper + palm kernel chaff	53.00	0.030
6	Sawdust + palm kernel chaff	56.09	0.030
7	Waste paper + sawdust + palm kernel chaff	56.09	0.030

Table 4: Compressive Strength Test

Sample No.	Sample Board	Compressive Strength (kpa)
1	Waste paper	1.39
2	Palm kernel chaff	1.29
3	Sawdust	1.19
5	Waste paper + sawdust	1.69
6	Waste paper + palm kernel chaff	1.59
7	Sawdust + palm kernel chaff	1.49
	Waste paper + sawdust + palm kernel chaff	1.88

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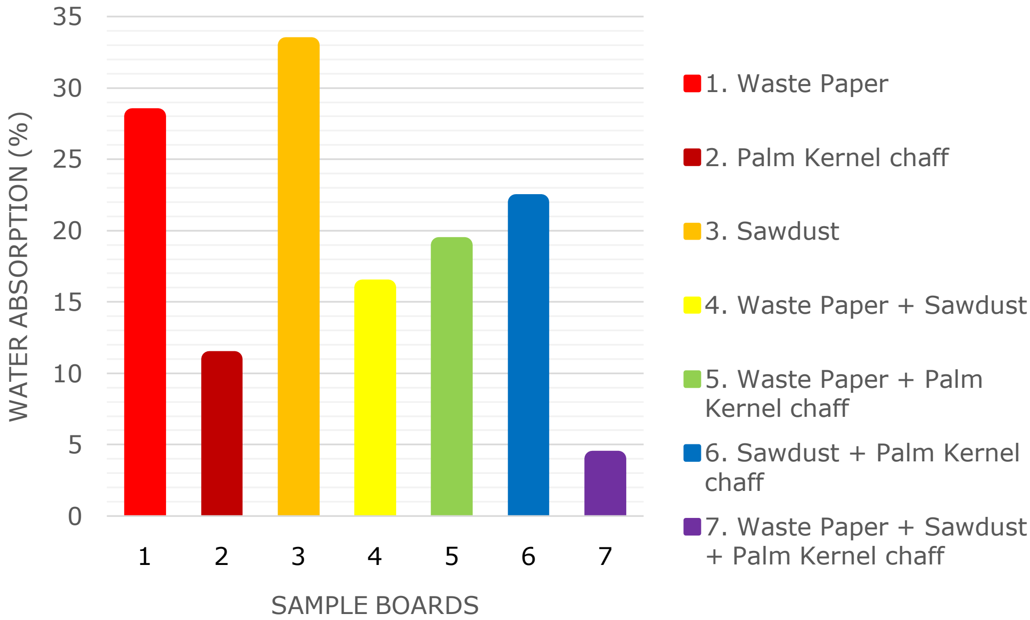

Figure 1: Water Absorption Percentage of Sample Boards

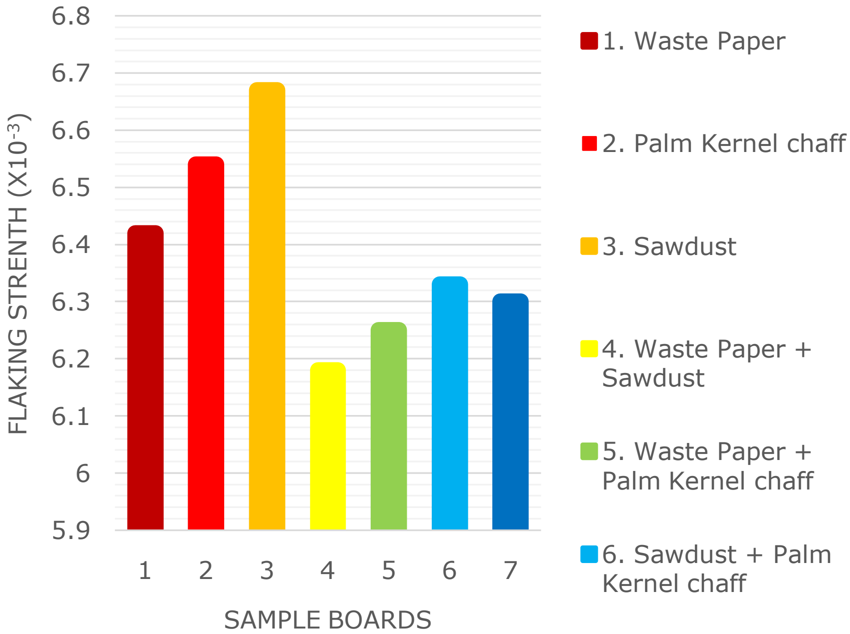

Figure 2: Flaking Test of the Boards

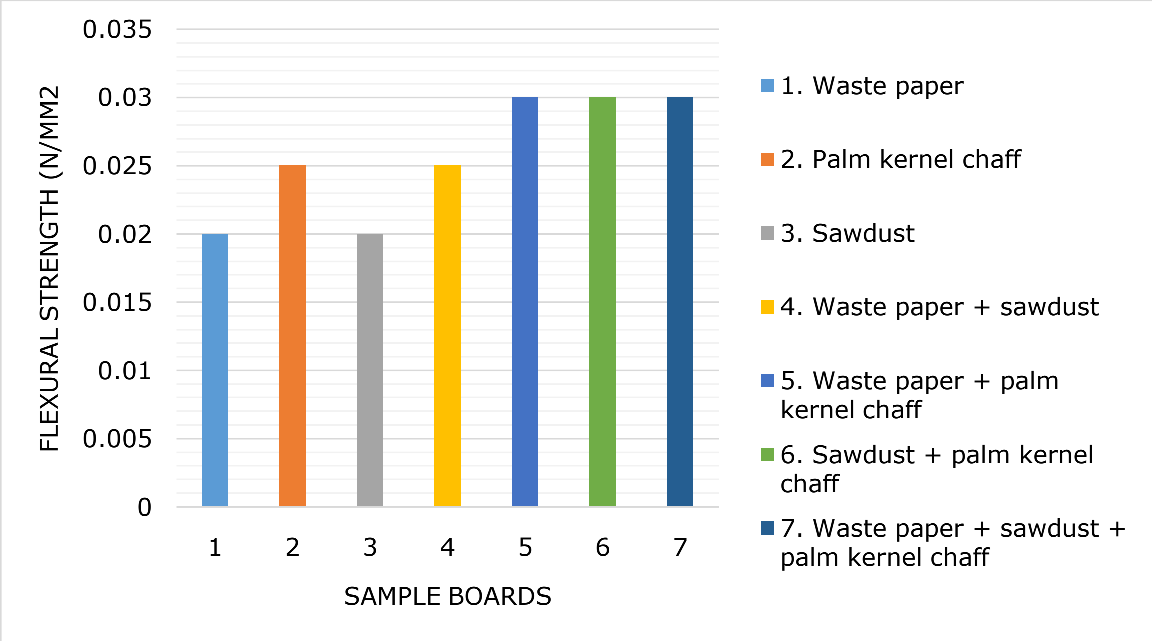

Figure 3: Flexural Strength Test

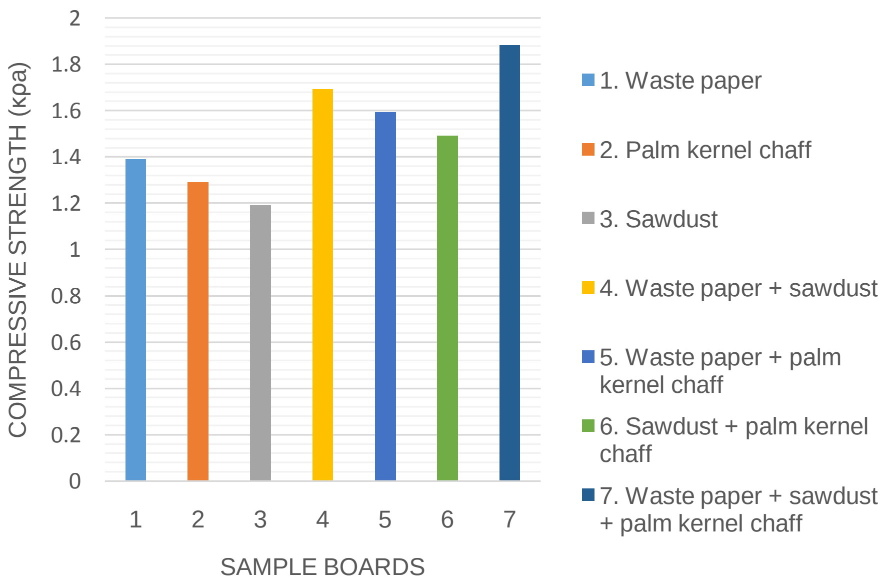

Figure 4: compressive Strength Test

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