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Properties of Plastic Bonded Agricultural – Waste Composites, I: Charcoal and Wood-Dust Separately Bonded Composites

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Abstract: *Eleven (11) composites, are unfilled and five each filled with varying contents of charcoal and wood dust separating bonded with melted spent thermoplastics have been compounded and their compressive strength, density, specific gravity, percentage shrinkage and percentage absorption determined.Composite density ranges (0.83-0.94)g/cm^3, compressive strength from (6.92-16.14)n/mm^2, percentage shrinkage from (1.01-4.76)% and percentage water absorption from (1.75-15.75)%. These results suggest that these composites (i) meet the allowable American standard for test and measurement (ASTM) for ceramic floor and wall tiles in compressor strength (0.2-22.1)minimum, % shrinkage (maximum 15%) and water absorption (maximum 16%) (ii)are appreciably strong compare to the gmelina-wood/cement composite and (iii) if comprehensively examined, composites may be useful in the building industry for the manufacture of tiles and boards and even compete favorably with the wood cement composites.*
Keywords: *Compressive strength, % shrinkage, % absorption, thermoplastic,tiles.*

I. Introduction

The reinforcement of inorganic matrices for improved structural integrity with linigocellulose fluids materials is an old option. Inorganic builders such as Portland cement have been used in building elements. Example of the different types of inorganic bonded wood composite industrially produced are magnesium bonded composite panel (1,2). They are used as particle partitioning, cladding, wall lining and paneling and roofing of floor base (3-5)

The use of cement builder in the production of particle boards has aroused interest lately probably because of the shortage and increase in the price of synthetic resin and the desire of develop boards that are suitable foe the exterior applications. The needed raw materials (cement and wood) are readily available in developing countries and the production technology is relatively simple. The cement bonded particle boards is reported (2, 6-8) to have better resistance to impact loading when compared with asbestos board stiffer than the unbound with a bond strength that increase progressively with period of exposure to structural weathering.

One of the many problems with cement bonded particle is that of which relates to the weight of the board. Commercially, the board is manufactured within the density range of 1100-1300kg/m^3 and with cement wood ratios ranging between 2.75 -3.00 cement to 1.00 of wood on weight basis (9). The large quality of cement per unit weight of wood employed in the board manufacture makes the resultant board to be heavy. It has been noted that the characteristically high density of the board is a possible limitation to the boards use particular in the areas where weight saving is essential. Deppe (10) noted the need for research effort directed towards finding ways of reducing density of the board while at the same time improving the strength of the board.This need is the aim of the present work.

The sale of pure water in plastic sachets without effective management of the sachet after the consumption of the water contains has resulted in environmental pollution caused by the non-biodegradable spent purer water sachet particularly in our cities in this country. In an attempt to control the menace, the spent sachet has been used as a binder in the production of particle boards separately consisting of charcoal and wood dust.

The compressive strength, % absorption and % shrinkage of the composites are reported in this write up.

EXPERIMENTAL

Materials spent pure sachet were collected from restaurants, washed and sun dried.

Filters: (a) Charcoal was bought at the Erekesan market Akure, washed, sun dried, crushed and sieved with endecotte sieve into an appropriate particle size and stored at 105^{0}C ready for use.

(b) Fresh and clean wood dust was collected from the mill, sun dried and sieved into the same particle size as the charcoal and stored at 105^{0}C ready for use.

Composite formulation: Eleven (11) composites formulated for this work are shown in table 1.

Curing: Spent sachets were and filled separately with charcoal and wood dust as contained in table 1. The resultant composites were introduced into a cylindrical and rectangular mould under pressure, allowed to cool, removed from the mould and kept in cold water for 24 hours.

Property Determination

i. Compressive strength: The cylindrical samples were tested using the appropriate machine ELE compact 1000.see table 2 for results.
ii. Density: Determined for each sample using the specific gravity bottle and weighing balance.
iii. Percentage shrinkage and percentage absorption were determined as reported by Samuel and Adeyemi (2004)

II. Results And Discussion

The compressive strength, specimen weight and density of the examined boards are shown in tables 1,2 and 3 respectively. The unfilled specimen shows a compressive strength of the charcoal boards as a function of charcoal content in the spent sachet/charcoal board goes not show any consistent trend (table 1 and 2).The compressive strength of the boards falls within the range of (9.64-16.14N mm^2 at a density range of (0.84-0.94)g/cm^3 as displayed in table 2 and 3.Comparing the compressive strength and the density of gmelina wood – cement boards of (170 270)kg/cm^2 at a comparable density range of 0.80/cm^3 and above (1) with those of the spent sachet-charcoal boards of (9.64 – 16.14)N.mm^2, it is observed that the spent sachet charcoal boards seems stronger.

The compressive strength of the sachet wood dust boards falls within (6.92 – 12.58)N/mm^2 at a density range of (0.86 – 0.90)g cm^2 as displaced in tables 2 and 3. The range for charcoal is wider than the range for wood dust within a comparative density range suggesting that charcoal is relatively more compatible with spent sachet than wood dust. The trend of compressive strength of wood dust board as a function of wood content in the components is similar to that of charcoal board: Also compared to the gmeline wood cement board the board the spent sachet/wood dust boards seems stronger.

The composites also show percentage shrinkage of (1.80 – 2.86)% and percentage absorption of (4.30 – 14.22)% for charcoal and percentage shrinkage of (4.00 – 8.00)% and percentage water absorption of (1.03 – 6.40)% for wood dust.

The allowable standard values recommended by the American standard for test and measurement (ASTM) for floor and wall tiles are: compressive strength of 22.1 MPA (22.1 N/m^2), minimum:% shrinkage of 15% maximum and % water absorption of 16% maximum, (Samuel and Adeyemi 2004). Comparing the composites under examination with this (ASTM) standard it is observed that all composites for which compressive strength standard was determined meet the compressive strength standard and the composites examined meet the % shrinkage and %water absorption standard for floor and wall tiles.

III. Conclusion

The result of this work has shown conclusively that:

i. The spent sachet bonded wood dust and spent sachet bonded charcoal boards are of comparative density but stronger than the cement bonded gmelina wood board
ii. The economics of the board's technology is more favorable for the unfilled spent sachet melt, sachet/charcoal and spent sachet/wood dust boards than for the cement/wood board in which cement constitute a costly component.
iii. The manufacture of the spent sachet boards result in the control of environmental pollution caused by the non – biodegradable spent pure water sachets littering our immediate environment.
iv. All composites meet the ASTM standard for wall and floor tiles
v. The boards studied in this work if extensively examined can result in its use as substitutes for the materials for which wood cement boards have been used for in the building industry.

Some properties of plastic bonded composites I:Charcoal and wood dust separately bonded with plastic

DATA:

Table 1: Compounding formulation of composites

Composite code	Components	
	Plastic (spent pure water sachet)	Filler
Plastic(P)	62.5	
Plastic/charcoal PC_1	62.5	9.2 charcoal
Plastic/charcoal PC_2	62.5	18.6 charcoal
Plastic/charcoal PC_3	62.5	27.6 charcoal
Plastic/charcoal PC_4	62.5	32.2 charcoal
Plastic/charcoal PC_5	62.5	41.4 charcoal
Plastic/wood dust PWD_1	62.5	4 .5 wood dust
Plastic/wood dust PWD_2	62.5	9.0 wood dust
Plastic/wood dust PWD_3	62.5	13.5 wood dust
Plastis/wood dust PWD_4	62.5	18.0 wood dust
Plastic/wood dust PWD_5	62.5	22.5 wood dust

Table 2: Properties determined for the composites

Composite code	Density g/cm^2	Specific gravity	% shrinkage	% absorption	Axial compressive strength N/mm^2
(P)	0.89	0.91	1.12	1.95	12.30
PC_1	0.88	0.90	4.76	5.30	12.88
PC_2	0.83	0.82	4.67	3.49	9.64
PC_3	0.89	0.90	4.12	15.0	9.88
PC_4	0.94	0.96	3.70	6.57	16.14
PC_5	0.93	0.94	3.90	15.0	10.09
PWD_1	0.89	0.90	2.73	1.75	10.69
PWD_2	0.90	0.93	2.54	3.51	12.58
PWD_3	0.88	0.89	1.52	12.11	7.31
PWD_4	0.88	0.89	1.01	1.77	11.58
PWD_5	0.86	0.89	3.64	15.75	6.92

TABLE 3:

Gmelina wood (1)	Approximate compressive strength N/cm^2
E_1 without extraction (wood)	170 kg cm^{-2}
E_2 hot water extraction(wood)	240 kg cm^{-2}
E_3 hot water and dilute sodium hydroxide extraction wood	270 kg cm^{-2}

TABLE 4:American standard for test and measurement allowable values for floor and wall tiles[11]

Compressive strength (MPa)	Breaking N	% water absorption	% total shrinkage
Floor tile 22.1 (min)	—	16% max	15% max
Wall tile 17.2 (min)	—	16% max	15% max

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