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Strength Properties and Potential Uses of Disused Water Sachet Cement Composites

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ABSTRACT

Health hazards oftentimes occur as a result of improper disposal of disused water sachet. Therefore, the feasibility of using disused water sachets as furnish in cement composite production as a means of curtailing was this menace investigated. Disused water sachets were collected, washed, dried and shredded into strips measuring 2.1 x 0.9 x 0.007 cm. They were blended with cement and water and formed in composite boards at 2% disused sachet content, 1:2 and 1:3 cement to sand ratio, and 0.45 water to cement ratio. The fabricated boards were conditioned for 28 days and tested for strength properties and dimensional stability. The results obtained revealed that the disused water sachet composites boards were dimensionally stable (water absorption and thickness swelling of 7.8 to 9.6% and 0.7 to 2.0% respectively after 2 and 24 hours soak in water) and of moderate strength applicable to interior and exterior insulating components in building construction

Keywords: Disused water sachet, Cement composites, strength properties and dimensional stability

1. INTRODUCTION

Water is an essential resource for life and good health. However, water shortage as well as access to safe water is a daily issue that threatens the health and living standards of the world population. This is because as cities and population grow and the demand for water increase in agriculture, industry and households, the quantity of water to meet these respective needs is on the decline (7, 1). Majority of the world's population, especially in most parts of Africa do not have access to safe drinking water. This is particularly so in Nigeria where the abundant water resources is largely untapped. Government at all levels (federal, state and local) have not been able to fully harness these resources to ensure a sustainable and equitable access to safe, adequate, improved and affordable water supply (6).

In this regard, a number of sachet water industries are arising in states of the federation. These industries produce mineral water of about 0.5 L meant for human consumption packaged and sold to members of the public in sealed nylons at motor parks, markets, public functions and street corner shops.

Sachet water offers the most accessible and quickest means of assuaging the feeling of thirst. Their relatively cheap and inexpensive nature compared to bottled water makes it a cherished and preferred commodity to many Nigerians. The growing popularity of this potable water unit in Nigerian cities makes it one of the fastest growing small scale businesses today (1). However, it has been noted (1) that the attitude exhibited by most consumers of sachet water in terms of littering and proper disposal of the used nylons is most worrisome. This is because of the huge environmental nuisance created by the non biodegradable nature of littered waste sachet water nylons. A means of curtailing the nuisance of improper disposal of these items may be in the production of environmentally friendly cement based composites. This could serve not only as low-cost building components for rural communities in need of affordable shelter but also help in enhancing the quality of our environment. This work therefore examined the production, testing and potential uses of shredded disused water sachets mixed with cement.

2. MATERIALS AND METHODS

Disused water sachets were collected in the premises of the University of Ibadan, Oyo state. These were manually washed, air dried for four days and shredded into strips of 2.1cm x 0.9 cm x 0.007 cm. Cement based composites were produced at the following levels:

Disused water sachet content:
2% (Based on weight of cement)
Cement: Sand Ratio: 1:2 and 1:3
Water: Cement Ratio: 0.45
Board Thickness: 7.0 mm

Shredded disused water sachets were mixed at the aforementioned production levels and poured into a wooden deckle measuring 150 mm x 60 mm placed on plastic caul plates in three replicates. The composites were de-moulded after 24 hours, placed in a conditioning room at a temperature 20 ± 3^{o}C and relative humidity of 65 ± 5% for another 27 days and then subjected to flexural and water resistance tests

Flexural Test

The flexural tests were conducted on a Universal Testing Machine at a cross – head speed of 1mm/min. The samples were loaded until failure occurred from which the moduli of rupture (MOR) and elasticity (MOE) were evaluated.

Water Absorption (WA) and Thickness Swelling (TS) Test

The test samples were weighed and then immersed in distilled water at room temperature first for 2 hours and then for 24 hours. At the end of 2 and 24 hours, each test samples were withdrawn from water and allowed to drain before the final weights and thicknesses were recorded.

The water absorption and thickness swelling for each test piece was expressed as a percentage of the initial weights and thicknesses.

3. RESULTS AND DISCUSSION

Moduli of Rupture and Elasticity

The moduli of rupture and elasticity (MORs and MOEs) of the composites were between 4.3 to 6.1 N/mm^2 and 2,084.8 to 4182.7N/mm^2 respectively (Table 1). These values compared with those reported in literature (2, 3, 4, 5, 8, 9) for cement bonded composites made from hardwoods and rattans. The MOR obtained for the disused water sachet composites suggests that they cannot be used for load bearing applications but as insulating components such as partitioning, floor and wall tiles in building construction. However, the high MOEs recorded for the composites suggest that the disused water sachets are suitable as furnish for cement composites production.

Generally, the MORs and MOEs of the composites decreased with increase in sand content attributable to poor interfacial bonding due to the reduction in cement content. However, while no significant difference ($p < 0.05$) existed in the MORs of composites bonded with cement: sand ratios of 1:2 and 1:3, the MOEs were significantly affected by the cement: sand ratios (Tables 1 and 2).

Table 1: Strength Properties of Disused Sachet water Cement Composites

Cement: Ratio	MOR	MOE
1:2	6.1 ^{A} (1.41)	4182.7 ^{A} (52.4)
1:3	4.3 ^{A} (0.39)	2084.8 ^{B} (27.5)

* Means with the same letters and columns are not significantly different
Standard deviation in parentheses

Table 2: Analyses of Variance of Moduli of Rupture and Elasticity of Disused Sachet water Cement Composites

Source	Df	Mean Square Value	
		MOR	MOE
Cement: Sand Ratio	1	4.79	1278,907.0*
Error	4	1.08	4801.40

* Significant and 5% level of Probability

Water Absorption (WA) and Thickness Swelling (TS)

The respective WA and TS of the disused sachet composites were between 7.8 to 9.6% and 0.7 to 2.0% after 2 and 24 hours soak in water (Table 3). These values compared favourably with those of cement composites made from hardwoods and rattan (4, 5, 8, 9). The values obtained for the sorption properties indicated that the disused sachet composites were dimensionally stable with low sorption rates. Hence, they can be used in interior and exterior applications in building construction.

Again, increment in sand content resulted in enhanced water absorption and thickness swelling attributable to poor interfacial bonding as a result of low cement content. Whereas soaking time and cement: sand ratios significantly ($p < 0.05$) affected the water absorption of the disused sachet composites, the thickness swelling of the composites were not affected by the same factors (Table 4).

Table 3: Water Absorption and Thickness Swelling of Disused water Sachet Cement Composites

Cement: Sand Ratio	Soaking Time (Hours)	
	2	24
	Water Absorption (%)	
1:2	7.8 ^{D} (0.18)	8.4 ^{C} (0.12)
1:3	9.0 ^{B} (0.24)	9.6 ^{A} (0.07)
	Thickness Swelling (%)	
1:2	0.7 ^{B} (0.49)	1.1 ^{AB} (0.82)
1:3	1.0 ^{AB} (0.88)	2.0 ^{A} (1.1)

* Means with the same letters and columns are not significantly different
Standard deviation in parentheses

Table 4: Analyses of Variance of Water Absorption and Thickness Swelling of Disused Sachet water Composites

Source	Df	Mean Square	
		WA	TS
Soaking Time	1	1.05*	2.97
Cement: Sand Ratio	1	4.3*	2.1
Error	9	0.027	0.75

* Significant and 5% level of Probability

4. CONCLUSION

The following conclusion can be drawn from this work:

i. It is feasible to produce environmentally friendly cement composites from disused water sachets.
ii. The fabricated composites were dimensionally stable and could be used as insulating composites for building construction

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