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Potential Uses of Waste Paper/Sludge as a Ceiling Material

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Abstract: This study discusses the safe and economic potentials of waste paper/sludge in the production of ceiling material with the need for better and more-cost effective production of the material. It discusses the mixture of cement with paper sludge to produce a suitable ceiling material. A review of existing published material is presented to illustrate the various mixture used and their respecting applications. Tests were carried out on the produced material to ascertain the suitability of waste paper/sludge as a ceiling material, this includes, Water absorption, drying shrinkage, flexural strength, thermal conductivity, nail ability, durability, compressive strength, fire resistance etc. the result shows that, the physical and mechanized properties, of the produced material showed a significant improvement and advantage over the conventional asbestos ceiling. The main component of recycled materials is waste paper/sludge.

Key words: Waste paper, paper sludge, mixture, recycling, ceiling material

INTRODUCTION

Reuse of waste materials is a waste minimization strategy which includes reclaim activities, (Howard, 1987; Collins, 1993). Waste materials can be reused directly or recycle to produce the same or another products, this has benefit in not only reducing the amount of waste material requiring disposal, but can produce production materials with significant savings over the new ones (Collins, 1993; Robin, 2002; USEPA, 2003; Ibhadode, 2004).

The reuse of waste materials can actually provide value to what was once a costly disposal problem (Robin, 2002; USEPA, 2003).

Waste paper has been a major solid waste problem in Nigeria, use has been found in most of the sutdy industries as a raw material for the production of new papers, such reuse not only solves a major disposal problem but also result in a cost avoidance bonus for the industries (Mistra, 1993; Bearmant, 1989).

While no extensive use in Nigeria has been made of the waste as ceiling material, in USA there have been a number of houses where it has been used as a substitute for asbestos which causes the disease called asbestosis (USEPA, 2003). In the production of the material, various materials employed in developing special mixtures of the sludge and combinations are discussed.

MATERIALS AND METHODS

Technology strategy formulation:

- Availability of material
- Sorting and collection
- Production techniques

Availability of materials: The possibility to meet the demand for waste paper for the production of this product was realized under the following:

- Collection of waste from industries and trade centers by waste paper traders.
- Separation of waste paper from municipal waste
- Reduce the loss paper.

Sorting and collection: During the separation of the mixture containing different materials present in domestic waste, the differences in physical properties of the material was utilized.

Hand-picking was also adopted to salvage waste paper from municipal waste.

Production technique: Describing the steps in Fig. 1. Waste papers are first cleaned mechanically to remove dust, impurities, and foreign matters. This is accomplished in hydro- pulper. During this stage there is a breaking up of waste papers in hot water to form a suspension of individual fibres and the formation of felted material, after the fibres have been sufficiently broken up, they are kept in suspension, at this stage the liquid material called pulp

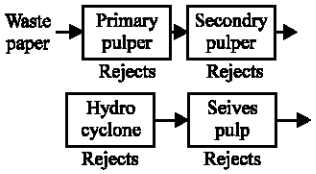

Fig. 1: Flow-sheet of preparation using waste paper (USEPA, 2003)

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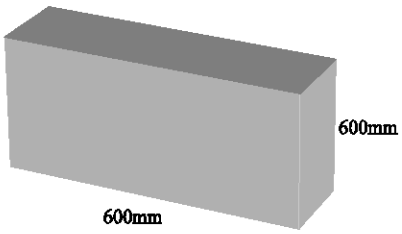

Fig. 2: Framework used in the production of the ceiling

is ready for the actual process of ceiling board, the second stage involves the pulp to be screened and filtered to remove smaller contaminants.

Appropriate quantity of cement is added to each grade of pulp and mixed thoroughly. The framework used in the production of the ceiling board is illustrated in Fig. 2. It is a square box of 600×600 mm.

Analysis of tests carried out

Water absorption test: Water absorption test was performed on the produced board samples according to ASTM D 1037-8 specifications this is express as

$$W.A = \frac{M_2 - M_1}{M_1} \times 100\%$$

Where

W.A = Water Absorbed

M_2 = Final weight of material

M_1 = Initial of weight of material

Drying shrinkage test: This test was performed as specified in ASTM C 426-70.

Flexural strength test: This test was performed as specified in ASTM D1037-78.

Compressive strength test: Compressive strength test was performed to determine various compressive strengths for grades 1:1, 1:11/2 and 1:2 using motorized CBR Machine.

RESULTS AND DISCUSSION

Quality of product: The dimensional accuracies of the average area (600×600 mm) for all ceiling boards produced are within standard, while the ceiling board thickness of 1.8±1.2 mm average vary within the limits of ±7.9%. This is because during compaction operation, there may be variation of the board thickness at the edges and board centers.

Table 1: The result of drying shrinkage test

Mix	Sample	Length (mm)	Length (over dry mm)	Change in length	Drying shrinkage %
1:1	A	350	349	1	0.4%
1:11/2	B	400	398	2	0.5%
1:2	C	300	298	2	0.5%

Table 2: The results of water absorption test

Mix	Sample	Dry weight (g)	Wet weight (g)	Amount of water absorbed	% water absorption
1:2	A	16.2	19.00	2.80	17
1:11/2	B	31.7	38.00	6.30	19.8
1:2	C	37.10	48.5	11.40	30.7

Table 3: The results of compressive strength test

Mix	Sample	Loaded area (mm^2)	Thickness (mm)	Compressive strength m mm^{-2}	PRF× Compressive strength
1:1	A	111.6	1.8	13.50	0.3375
1:11/2	B	61.2	1.8	9.00	0.225
1:2	C	45	1.8	7.59	0.1875

Where PRF= Power Ring Factor which is equal to 0.025

- The physical and mechanical properties of the produced ceiling board indicated that the material is light weight.
- The linear shrinkage of the produced ceiling board ranges from 0.4% for the mix 1:1 to 0.5% for the mixes 1:1½ and 1:2, these percentage linear shrinkage of the produced ceiling board fall within the maximum percentage linear shrinkage of 0.5% specified for building board in ASTM 208-75 (Table 1).
- It is necessary for materials used in ceiling board to have a very low water absorption, Result of water absorption test carried out indicated that sample from mix 1:2 has the highest percentage of water absorption of 30.7% and samples from mixes 1:1 and 1:1 ½ have percentage of water absorption of 17 and 19:8% respectively. This shows that more water is absorbed with increasing quantity of pulp (Table 2).
- The compressive test results shows that the compressive strength increase with significant increase in cement content. Too much of pulp to cement leads to brittleness (Table 3).
- The highest flexural strength of 0.25 mm^{-2} for a sample produced from mix 1:1 was achieved. Other values are 0.23N mm^{-2} and 0.18N mm^{-2} for samples produced from mixes 1:1 ½ and 1:2, respectively, Notwithstanding, these values are short of the minimum value of rupture 2 N mm^{-2} specified in ASTM 208-72 (Table 4).

Table 4: The result of flexural strength test

(a) For Mix 1:1	
Load (N)	Deflection (mm)
0	0.00
1	0.01
3	0.03
5	0.07
7	0.13
9	0.16
11	0.17
13	0.20
15	0.25
17	Failure

(b) Flexural Strength for mix 1:11/2	
Load (N)	Deflection (mm)
0	0.00
1	0.05
2	0.08
4	0.10
6	0.17
8	0.21
10	0.23
13	Failure

(c) Flexural strength for mix 1:2	
Load (N)	Deflection (mm)
0	0.00
1	0.05
2	0.10
4	0.17
6	0.18
8	Failure

Summary of flexural strength test			
Mix	1:1	1:11/2	1:2
Ultimate load (N)	15	10	6
Maximum deflection (mm)	0.25	0.23	0.18
Load at limits of proportionality	7	4	2

CONCLUSION

Based on the availability of waste paper, it is concluded that waste paper should be recovered by reuse and recycle it to make products like ceiling board. The paper industries, local authorities and other public bodies should be enlighten to play an important roles in minimizing the amount of waste paper being discarded. So, the recycling of waste paper needs to be promoted and encouraged because it is one of the most significant wastes generated in Nigeria in terms of volume.

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