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Producing Ceiling Sheets from Locally Sourced Materials

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ABSTRACT

The study focused on the production of ceiling board using rice husk and sawdust. Both raw materials are found in abundance locally and sometimes they constitute environmental hazard. Likewise, the use of locally sourced agricultural waste also eliminates the health risk posed by asbestos. Rice husk and sawdust are mixed properly in the ratio of 40:60, 50:50 and 60:40. The produced ceiling boards were tested for flexural strength, wear rate, water absorption rate. From the obtained result, it was observed that sample R40S60 has the highest flexural strength of 1.688N/mm2. It also has the least wear loss of 33.3% and highest wear resistance property of 3.003/kg. However, it also absorbed 49.9% of water as against 33.3% absorbed by other samples. It is worthy to note that all samples exceeded the minimum flexural strength of 0.018N/mm2 recommended for Gypson ceiling board

Keywords: Producing Ceiling Sheets, Locally Sourced Materials, Ceilng Board

1. Introduction

A ceiling sheet is used in the construction industry to cover the upper section of a room or internal space. The demands for ceiling sheets have been increasing with the increasing world population that resulted in massive development and construction worldwide. The major function of the ceiling in the building is sound and heat resistance as well as the provision of additional aesthetics. Yakubu et al (2017) while citing Ebeh (1997) stated that for performance standards, the recommended thermal conductivity of ceiling boards should be within 0.50-0.15 W/mK. Badejo (2001) opined that ceiling sheets with their upper surface are highly reflective; having good heat insulation and low thermal capacity is recommended in tropical climates. Ceiling boards are primarily produced using Asbestos a fiber present naturally in rocks. Asbestos was used because of its high tensile strength, poor heat conductivity, and high fire resistance (Amenaghawon et al., 2016). However, all types of asbestos fibers are known to cause serious health hazards to humans with Amosite and Crocidolite considered as the most hazardous. The continual use of asbestos for ceiling board products will continue to pose a high health hazard to both occupationally exposed people and residents who lived close to asbestos factories and mines (Kanarek 2011; Amenaghawon et al., 2016). Asbestos ceiling boards are generally fragile, pose health risks, and are relatively costly. Hence, there is a compelling need for cheap alternative products, using local organic materials that are human and environmentally friendly. Some of these substitute materials may include shredded wood, cellulose fiber agricultural waste which best suited the socio-economic circumstances of developing countries are natural fibers.

The word "waste" readily brings to mind any unwanted, non-useful item that has outlived its usefulness and needs, and is usually to be disposed of immediately not minding the effects of such disposal practices on the environment (Achadu et al, 2020). Processing of agricultural products like rice hulling generates a lot of agricultural waste in the form of husk which is most often gotten rid of by burning or dumping in waterways. Sawdust obtained from timber processing and woodworks is disposed of in the aforementioned ways. The idea of this study will help to explore the potentials of using the local and inexpensive available waste materials in producing ceiling sheets that are environmentally friendly at a low cost. This will enhance reducing the rate of air pollution, water pollution due to the dispersal of these bio-wastes.

Bio-composite is fabricated by combining natural fibers in a matrix material. A composite material is composed of reinforcement (fibers and particles) embedded in a matrix that holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. When these materials are combined, it makes the composite obtain better strength than when the materials are used individually.

This work aims to investigate the production of ceiling sheets from sawdust and rice husk.

Objectives of the Study

i. To study the suitability of sawdust and rice husk in the production of ceiling sheets.

ii. To vary the proportion of the sawdust and rice husk while determining the physical properties of the ceiling sheet developed from each combination ratio.

iii. To produce a ceiling sheet with reduced cost to discourage high rate of importation, thereby helping our country Nigeria to boost her foreign exchange and economic status.

2. Materials and Method

Materials

Rice husk, sawdust, epoxy resin and hardener, Portland cement, water, and used engine oil are the materials used for this research. The rice husk and sawdust were sourced locally from Ugbawka Rice Mill and Timber shed Kenyatta. Epoxy resin and hardener were obtained from Alaba International Market Lagos. Portland cement was obtained from Kenyatta Market, Enugu while used engine oil was sourced from a local Mechanic workshop.

Material Preparation

The sawdust was dried under the sun to dehydrate for proper sieving. Sieving was done to remove unwanted materials present in it and also to obtain particles sizes between 0 to 1500 μm.
The rice husk was properly sieved to separate from foreign particles. It was partially burnt black ash in other to reduce its fuel property; it is done to reduce the propagation of burning by the ceiling board in any case of fire

outbreak. The incomplete combustion of the rice husk gave a black rice husk ash after which it was allowed to cool. Finally, the Rice Husk Ash was sieved to obtain particles sizes between 0 to 1500 µm.

Figure 1: Partially burnt Rice Husk ash

Production of the Ceiling board

The stir casting method was used in the formation of the ceiling board. The percentage weight of both the rice husk ash and sawdust for each sample was measured out, added together, and thoroughly mixed with 250g weight of cement in a separate bucket. 270g of water, 70g of Epoxy resin, and 35g of the hardener were measured and mixed in another bucket and stirred for 2 minutes.

The mixture of the rice husk ash, sawdust, and the Portland cement was then poured into the bucket containing the epoxy resin, water, and epoxy hardener slowly and stirred at the same time till it becomes slurry. Used engine oil was applied lightly on the mold to serve as a lubricant before continuing with the casting. The slurry mixture was poured into the wooden mold and the casting was allowed to dry before ejection.

This process was also repeated for all three samples having different weight percentages of rice husk ash and sawdust as listed in the table below

.

Table 2.1 Weight of compositions of materials used

Sample	Rice Husk (%wt.)	Sawdust (%wt.)	Epoxy Resin (g)	Epoxy Hardener (g)	Cement (g)	Water (g)
$R_{40}S_{60}$	40	60	70	35	250	270
$R_{50}S_{50}$	50	50	70	35	250	270
$R_{60}S_{40}$	60	40	70	35	250	270

The composite ceiling sheet was dried at room temperature for uniform drying. The ceiling sheet was ejected after 24 hours and was allowed to dry more for four days before carrying out tests of the different samples.

3. Results and Discussion

Flexural Test Result

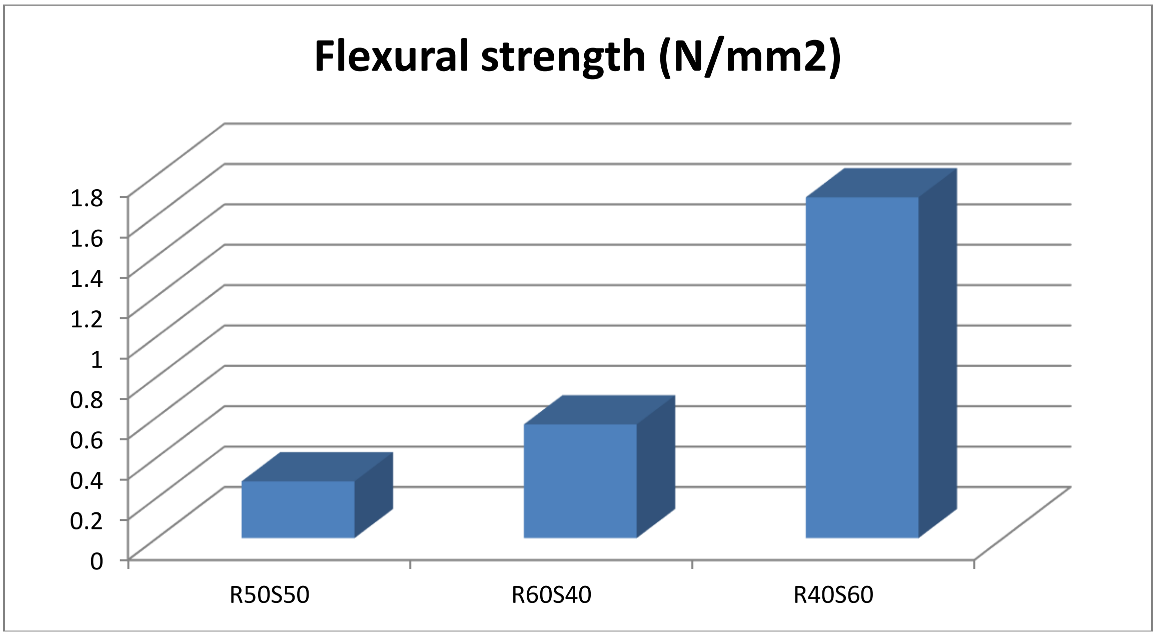

Figure 2: Flexural strength of the samples

It was observed that sample $R_{40}S_{60}$ with a flexural strength of 1.688N/mm^2 was able to absorb a flexural force of 30N before rupture, sample $R_{50}S_{50}$ absorbed a flexural force of 5N and had a flexural strength of 0.281N/mm^2 while sample $R_{60}S_{40}$ absorbed a flexural force of 10N and had a flexural strength of 0.563N/mm^2. All samples exceeded the minimum flexural strength of 0.018N/mm^2 recommended for the Gypsum ceiling board (ASTM 2004). The asbestos board has average flexural stress of about 1.00 N/mm^2 (Obam, 2012).

Wear Test Results

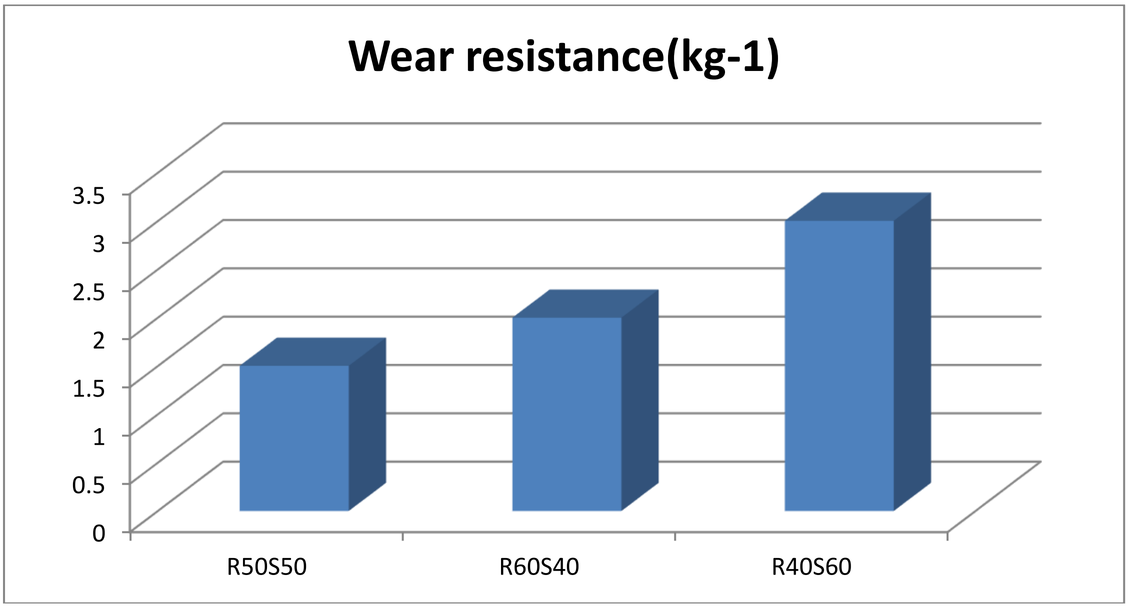

Figure 3: Result of the wear test for all samples

According to the wear test results in figure 3. Sample $R_{40}S_{60}$ has the least wear loss 33.3% weight and the highest wear resistance property of 3.003kg^{-1} when affected by a wearing agent at the speed of 0.599m/s. this may be attributed to the high percentage of sawdust (60%) than rice husk ash (40%). Sawdust is known to have a special tough property when mixed with epoxy resin and this has improved the wear resistance.

Sample $R_{50}S_{50}$ was equally observed to have a percentage wear loss of 66.6%, wear rate of 0.01110 kg/s and wear resistance of 1.502kg^{-1}. While sample $R_{60}S_{40}$ recorded a percentage wear loss of 50.0%, wear rate of 0.00833 kg/s, and wear resistance of 2.000kg^{-1}. The negative values that were obtained on the table under percentage wear loss only show that there is a reduction in the weight of the test sample after some wear action had taken place on the material.

Water Absorption Test Results

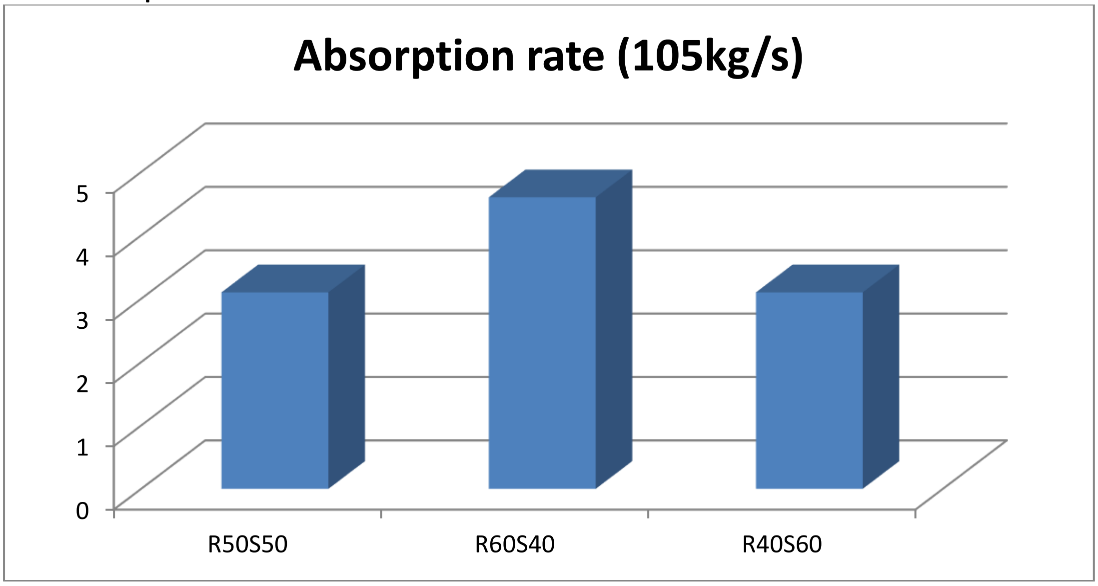

Figure 4: Result of analysis of water absorption test

It was observed that sample $R_{40}S_{60}$ and sample $R_{50}S_{50}$ were able to absorb 33.3% of water when immersed in a bowl of water for 3hrs, this resulted in a water absorption rate of 3.1×10^5kg/s. while sample $R_{60}S_{40}$ absorbed 49.9% of water with a 4.6×10^5kg/s absorption rate. This implies that the rice husk ash creates much space where water can be trapped in the material than when there is a high percentage of sawdust Yakubu et al (2017). Also, Pozzolanic materials have a high-water absorption rate. Therefore, the higher the quantity of rice husk ash in the specimen than the higher the absorption rate.

4. Conclusion

It can be concluded from this study;

i. That partial burnt Rice husk ash and sawdust can be used to produce ceiling boards locally.
ii. Sample $R_{40}S_{60}$ with high wear resistance and low water absorption rate can be very useful most especially in humid areas because of its low water absorption rate.
iii. That the fire-resistant property of the material can be improved more by increasing the amount of the fire retardant making it obtain most of all the desirable properties.
iv. That the result of this work could provide competitive composite ceiling boards for construction and, at the same time, be environmentally friendly. Developing countries should make an effort to harness the potential of the abundantly available rice husk and sawdust

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