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Sustainable Indigenous Technology For Low- Cost Housing Delivery In Nigeria: A Case Study Of The Production Of Roofing Tiles Using Rice Husk

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Abstract: ***The aim of this study was to appraise the applications of indigenous technology in the production of roofing tiles for low-cost housing using rice husk. The study considered three mix proportions of rice husk roofing tile matrices, samples A, B and C. All the samples were subjected to impact strength test to measure the amount of energy each sample roofing sheet could absorb. The study revealed that sample A had an impact resistance of 8.40 joules as compared to 12.60 joules used as control for corrugated asbestos roofing sheets. Sample B had an impact of 10.55 joules while sample C had an impact of 6.51 joules. The best impact strength was demonstrated by sample B which was treated with Potash. The study therefore concluded that Corrugated Rice Husk roofing sheets compare favorably well with their asbestos counterparts. The use of Potash in the mix for rice husk based corrugated roofing sheets enhances their impact strengths.***

Keywords: Rice, Husk, Impact, Strength, Roofing, Sheets, Corrugated

I. INTRODUCTION

Rice husk is one of the agricultural bi-products that have been wasted for many years in Nigeria. The harvested rice kernel known as *paddy* is enclosed by the *hull* or *husk*, otherwise called *rice husk*. To obtain rice husk, the rice *paddy* is parboiled, dried and milled to separate the rice from the *husk*. Rice is produced in most states in Nigeria, such as Anambra, Enugu, Delta, Edo, Imo, Abia, Ebonyi, Kaduna, Kano, Kwara, Niger, Lagos, Ogun, Ondo, Ekiti, Rivers, Benue, Plateau, Sokoto and Kebbi States, plus the Federal Capital Territory (Abuja). The cities in Nigeria where rice is massively grown and produced are Abakaliki, Afikpo, Ogoja Odoro and Ikepe (around the Cross River plains), Lafiagi, Badeggi and Pategi (around the shores of River Niger), Sokoto and Brini-Kebbi (around the valley of River Sokoto) and Abeokuta, Benin and the Delta Region.

The building industry in Nigeria is plagued by shortage of construction materials. The situation is compounded by the high cost of conventional building materials most of which are imported. The pillars of housing and other real estate market (land, finance and building materials) are beyond the reach of the ordinary Nigerians. Thus, people have difficulties building houses of their own. Hence most tenants in most city centres throughout the country have to surrender themselves to fate as they live in constant fear of shylock landlords, caretakers and estate agents who would either increase house rents sporadically or give quit notice to their tenants for better rentage. While the qualities of comfort in most houses are reducing, rent and other fees are increasing.

The provision of decent, affordable medium and low income housing units by various governments has not been successful. Given the prevailing economic situation, a good number of Nigerians cannot afford decent shelter for themselves. The importation of building materials and the absence of the use of locally-sourced materials in the production of building materials has led to a number of problems in Nigeria. There is lack of self-reliance in the execution of our building projects. Unemployment rate is getting out of hand due to lack of small scale industries. The establishment of the primary Mortgage institution (PMI), and the enunciation of the National Housing Policy (NHP) and the

establishment of building societies have not helped at all. The only meaningful option left for the government and the Nigerian citizenry is to look inward and to encourage the production and development of roofing sheets and other building materials with locally-sourced materials through research venture. In an unpublished raw data Ezeji (1995) emphasized the need for a study on rice husk as a roofing material.

One of the locally available materials that could be used in the production of roofing sheet is rice husk. Rice husk is usually found in heaps by the road sides, river banks or nearby building in rice producing and processing communities in Nigeria. The evacuation of the heaps of rice husk from our environment especially in the middle belt of Nigeria and other rice-producing areas has become a big problem. The heaps of rice husk contribute immensely to environmental pollution, degradation and hazards. In an attempt to dispose of rice husk, most communities put fire on it. Unfortunately, a small heap of rice husk takes months to get burnt to ashes. Even when converted to ashes, it is still an eye sore in the towns especially during the rainy season. Rice husk dumps on fire constitute serious hazards in the community. Hence, it has become necessary to rid the environment of rice husk waste and to make it be of some positive economic importance to Nigeria. Thus, this study is an effort to use rice husk in the production of corrugated roofing sheets.

II. AIM AND OBJECTIVES OF THE STUDY

The aim of this study was to investigate the use of rice husk in the production of roofing sheets towards a sustainable indigenous technology development for low- cost housing delivery in Nigeria. The specific objectives were:

- ✓ Identification of materials for the production of roofing sheets;
- ✓ Treating the rice husk;
- ✓ Production of the rice husk roofing sheets;
- ✓ testing the samples of the produced rice husk roofing sheets for permeability, breaking load (malleability, ductility, resilience), surface defects, water absorption, density and fire resistance and
- ✓ comparing the properties of the rice husk roofing sheets with Asbestos roofing sheets, with a view to finding out its effectiveness as roofing material

III. CHARACTERISTICS WHICH ASBESTOS SHARE WITH RICE HUSK AS ROOFING SHEET MATERIALS

A. FIRE RESISTANCE

Hornbostel (1991) revealed that Asbestos is fire resistant. He added that though Asbestos is fire resistant, it could deteriorate as a result of loss of water of hydration at a very high temperature of 725^0F and above. At temperatures of between 1100^0F and 1400^0F all the molecules in Asbestos will evaporate and the resultant effect is loss of strength and embrittlement. However, for roofing purposes the level of fire resistance of asbestos is very adequate.

Ukpon (1991) revealed that rice husk does not burn in flame. He noted that the rate at which rice husk burns is very slow which indicates that rice husk is fire resistant. In an attempt to burn rice husk into ashes, the researcher discovered that rice husk is converted to ashes at the temperature of 800^0F. In addition to the report of Ukpon &Roger (1987) in a study of chemical composition of rice husk revealed that rice husk is fire resistant. The results showed that rice husk recorded zero percent ignition loss.

B. HEAT RESISTANCE

Hornbostel (1991) reported that Asbestos is resistant to heat. He noted that Asbestos roofing sheets have cooling effects on a building. Hornbostel also recorded that Asbestos is a non-conductor. Naomichi (1989) noted that rice husk can be used as a superior siliceous material for the manufacture of calcium silicate heat-insulating material with a good thermal durability of 100^0C. This indicates that rice husk is resistant to heat.

C. RESISTANCE TO WATER PENETRATION

Hornbostel (1999) revealed that Asbestos is resistant to moisture penetration. Hence, Asbestos roofing sheet does not allow the passage of water through it. He also noted that Asbestos is resistant to corrosion and chemical attacks. In support of the fact that rice husk is water resistant, Okorie (1988) reported that rice husk is coated with cuticle, a biological membrane which is resistant to water penetration. Rice husk ash increases the resistance of cement-stabilized soil to sulphate attacks. Hence rice husk is resistant to corrosion and chemical attacks.

D. LIGHT WEIGHT

Hornbostel (1991) stated that Asbestos is light in weight. The weight of a building material is a very important factor in the construction industries. One of the biggest problems in the construction industry today is how to reduce the weight of concrete elements and at the same time achieve a high strength capacity. Naturally rice husk is very light in weight.

IV. MATERIALS AND METHODS

A. MATERIALS

The materials for the production of the roofing sheets included:

- ✓ Ordinary Portland cement;
- ✓ Clean dry rice husk;
- ✓ Waste paper;
- ✓ Marble dust (used as filler) and red oxide pigment for decoration purposes and
- ✓ Clean water.

B. TREATMENT OF RICE HUSK

Three different treatments were given to three different batches of rice husk respectively. The three treated batches of rice husk were used to produce the three different samples of roofing sheets which were subjected to test. From the test results it was easy to ascertain the best treatment to be given to rice husk before using it in the production of roofing sheets.

a. RICE HUSK TREATMENT BY BOILING

This batch of rice husk was boiled, well washed and dried before use in the production of the roofing sheets. This is because Parry (1985) reported that in addition to separation, washing and drying, fibre for cement-fibre concrete should be boiled to remove cement retarding chemicals. Maslehudeen (1990) in a study of chemical effects on concrete stated that calcium, magnesium, salts of sulphate, chlorides and carbonates extensively contaminate ground water and aggregates. He noted that if the materials are not well washed and dried, it could result in the swelling of the cementitious material and formation of cracks.

b. RICE HUSK TREATMENT WITH POTASH (AKANWU)

This batch was soaked with potash in water overnight. After soaking the rice husk overnight, it was well washed so that all impurities and oily substances were washed off. The rice husk was soaked in water with potash because potash removes oily substances instantaneously. Okorie (1988) revealed that oil is processed from bran which is a bi-product of rice milling. This indicates that there are some oily substances present in rice husk. Parry (1985) recorded that fibre having the following properties are not suitable for building materials: stiff fibre, oily or greasy to touch, impregnated with cement-affecting chemicals, presence of sugar and fibre susceptible to large dimensional changes when changing between wet and dry states.

c. RICE HUSK BURNT INTO ASHES

This batch of rice husk was burnt into ashes using a laboratory electric furnace with digital thermo-controller at a high temperature of 800^0C. This rice husk was not burnt in the open air because the colour of the ashes would become black instead of the grey. The rice husk ash is a pozzolanic material. Pozzolanic materials are not inherently cementitious materials. They react with lime and water to produce compounds with cementitious properties. The rice husk was also burnt into ashes in order to convert the organic substances in it, into inorganic substances. Onyemachi (1994) in a study of the utility of rice husk and its derivative in the building industry, converted rice husk into rice husk ash before using it in the formation of concrete cubes. Onyemaechi noted that, by converting rice husk into ashes all the organic substances that would otherwise create inadequate bonding in the concrete would have been destroyed and rendered inorganic.

C. SAMPLES

SAMPLE A: combination of Rice Husk Ash, cement, waste paper and a little addition of marble dust. The rice husk was treated by burning it in a furnace up to a temperature of 800^0C in order to convert it to ashes. The combination was mixed with water and cast into sheets and allowed to set and cure before testing.

SAMPLE B: combination of Rice Husk, Cement, waste paper and a little addition of marble dust. The rice husk was treated by soaking it overnight in potash (Akanwu) and water. The rice husk was well washed and dried before use. The combination was mixed with water, cast into sheets and allowed to set and cure as in Sample A.

SAMPLE C: combination of Rice Husk, cement, waste paper and a little marble dust. The Rice Husk was treated by boiling in water, washed and dried before use. The combination was mixed with water, cast into sheets and allowed to set and cure as in samples A and B.

V. RESULTS

SAMPLE	IMPACT ENERGY ABSORBED (JOULES)	CONTROL (ASBESTOS)	REMARKS
A	8.40	12.60	Good
B	10.55	12.60	Very Good
C	6.51	12.60	Fair

Table I: Results of Impact Strength tests for sample roofing sheets

VI. DISCUSSION

From table I above, sample A had an impact resistance of 8.40 joules as compared to 12.60 joules used as control for corrugated asbestos roofing sheets. Sample B had an impact of 10.55 joules while sample C had an impact of 6.51 joules. The best impact strength was demonstrated by sample B which was treated with Potash.

VII. CONCLUSION

Corrugated Rice Husk roofing sheets compare favorably well with their asbestos counterparts. The use of Potash in the mix for rice husk based corrugated roofing sheets enhances their impact strengths.

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