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MILLET HUSK ASH AS PARTIAL REPLACEMENT OF CEMENT IN SANDCRETE BLOCK

Mr. Solomon Ikechukwu Anowai[1], Mr. Jonas Ekene Afunanya[2]

[1]*Lecturer, Department of Building, University of Jos, Nigeria*
[2]*Lecturer, Department of Building, University of Jos, Nigeria*

Abstract – *This research is aimed at determining the suitability of millet hush ash (MHA) as partial replacement of cement in the production of sandcrete blocks. This study examined the physical and chemical properties of locally sourced millet husk ash as a pozzolana. Mix ratio 1:6 (cement: sand) was used in this study for sandcrete block production. Cement was partially replaced with MHA in varying percentages of 0, 10, 20, 30 and 40% by weight. The blocks were molded and cured for 7, 14 and 28 days. The compressive strengths of the blocks were determined at 7, 14 and 28 days by crushing using compressive strength testing machine. The result of the chemical analysis of the locally sourced millet husk ash showed that it is pozzolanic. At 28 days, the compressive strength of mixes with 0, 10, 20, 30 and 40% replacements of cement with MHA were 4.50, 4.00, 3.15, 2.00, and 1.15N/mm² respectively. Sandcrete blocks made with 10 and 20% replacements of cement with MHA met the minimum requirements for sandcrete blocks. The water absorption of Millet husk ash sandcrete blocks were found to be within the acceptable limits. This study recommends partial replacement of cement with 20% millet husk ash in sandcrete block production.*

Key Words: Millet Husk Ash, Sandcrete blocks, Partial replacement of cement, compressive Strength, Water absorption

1. INTRODUCTION

Sandcrete block is a composite material made up of cement, sand and water moulded into different sizes [1]. Among the material used in the production of sandcrete blocks, cement is the most expensive. As a result of high cost of cement, it has become extremely difficult for majority of the people to own their own houses and many structures collapse in attempt to reduce cost of infrastructural development [2]. According to [3] the high and increasing cost of constituent materials of sandcrete blocks has contributed to non-realization of adequate housing for both urban and rural dwellers.

Many researchers have recommended partial replacement of cement with pozzolanas as a way of reducing the cost of sandcrete and other cementitious composites. [4] defined pozzolana as siliceous and aluminous materials which in themselves have little or no cementitous properties but in finely divided form and in the presence of moisture, they can react with calcium hydroxide which is liberated during the hydration of Portland cement at ordinary temperatures to form compounds possessing cementitous properties. Pozzolanas are divided into two categories namely natural and artificial. The major sources of natural and man-made pozzolana include agricultural bye products, volcanic mineral deposits, fired and crushed clay, and and fly ash, which is created during the burning of coal for power generation [5]. In recent years, the industry has shifted to using natural pozzolanas because of their lower cost and accessibility [6].

Apata, A.O. & Alhassan [7], evaluated locally available pozzolanic materials and concluded that cement could be replaced by at least 10% locally available pozzolanas for low cost housing. Researches on the use of pozzolanic ashes from agricultural by product as partial replacement of cement in sandcrete blocks production gave promising results. [8] reported saw dust ash as a suitable pozzolana for sandcrete block production. [9] found that upto 25% rice husk ash could be used to partially replace cement in sandcrete block production. [10] found the optimum replacement of cement with saw dust ash as 10% for sandcrete block of mix 1:8 (cement: binder) with water cement ratio of 0.55. Addition of a pozzolana in cement-based product improves the properties of the cement and also reduces the cost of construction [11].

This study investigated the suitability of millet husk ash (MHA) as a partial replacement of cement in sandcrete blocks. Millets are small seeded species of cereal crops or grains widely grown around the world for food and fodder [12]. Millet husk is a bye product left after harvesting of millet.

2. EXPERIMENTAL DETAILS

The cement used for this study was "Dangote" brand of 42.5 grade ordinary Portland cement (OPC) conforming to requirements of [13]. The specific gravity of the cement is 3.15. The millet husk ash used in this study was sourced from Shendam, Plateau State, Nigeria. Burning the millet husk at of 500°C produced the Millet hush ash. The chemical analysis of the ash was carried out at Nigerian Geological Survey Agency Laboratory, Kaduna, Nigeria. The sand used for this study is clean river sand sourced from Gumo in Toro Local Government area of Bauchi State Nigeria. The water absorption, specific gravity and bulk density of the fine aggregates used are 0.71, 2.61 and 1600kg/m² respectively. The result of sieve analysis showed that the fine aggregate falls under zone 2 given in [14]. The water used in this study is in compliance to the recommendations of [15]. The water

was obtained from taps in concrete laboratory of Department of Building, University of Jos.

In this study, 225mm x 450mm hollow blocks were produced at the concrete laboratory of the Department of building University of Jos. Mix ratio 1:6 (cement: sand) was used in this study for sandcrete block production. Cement was partially replaced with MHA in varying percentages of 0, 10, 20 and 30% by weight. Water binder ratio of 0.5 was adopted for this research. For each replacement levels, 12 sandcrete block samples were cast. The blocks were molded and cured for 7, 14 and 28 days. The block samples were cured by constant sprinkling of water to keep the surfaces of the block samples moist. The compressive strengths of the blocks were determined at 7, 14 and 28 days by crushing using compressive strength testing machine in accordance with the standard procedure given by [1]. Water absorption test was also carried out on the block samples after 28 day curing in accordance with [1].

2. RESULTS AND DISCUSSION

2.1 Chemical and Physical Analysis Millet Husk Ash

The result of chemical analysis of MHA is presented in table 1. The result show that the sum, $SiO_2 + Al_2O_3 + Fe_2O_3$ is 70.1% which is slightly greater than the minimum of 70.0% specified in [4] for pozzolanas. The ash also satisfies the [1] requirement for the loss on ignition, which puts it at a maximum of 12. This result confirms that MHA can be used as pozzolana. The specific gravity of the MHA was found to be 2.3.

Table -1: . Chemical Composition of MHA

Constituent	Percentage Composition
SiO_2	63.7
Al_2O_3	3.80
Fe_2O_3	2.60
CaO	0.02
MgO	0.03
Na_2O	1.14
K_2O	20.1
P_2O_3	4.10
MnO	0.05
SO_3	2.06
TiO_3	0.16
Cl	2.15
Br	0.07
Loss on Ignition	11.20

2.2 Compressive Strength

The variations of compressive strength of the mix proportions with various percentage replacements of cement with MHA are presented in Figure 1. The results show that the compressive strength decreases with increase in MHA content for all ages of curing. For lower percentage replacements levels of 10 and 20%, the silica from the pozzolana is in required amount and contributes to the hydration process resulting to sandcrete blocks with high compressive strength. At 30% MHA and 40% MHA replacement levels, the quantity of the MHA is the mix is higher than the amount required for pozzolanic reaction with calcium hydroxide liberated as a result of hydration of cement. The excess silica contributes nothing to hydration of cement and consequently resulting to reduction in compressive strength [16]. The compressive strengths generally increased with age of curing. At 28 days, the compressive strength of mixes with 0, 10, 20, 30 and 40% replacements of cement with MHA were 4.50, 4.00, 3.15, 2.00, and 1.15N/mm^2 respectively. The compressive strengths of sandcrete blocks made with 10 and 20% replacements of cement with MHA met the minimum requirements for sandcrete blocks specified in NIS 87 (2004) which is between 2.5N/mm^2 to 3.45N/mm^2. At 30 and 40% replacement levels, the compressive strengths fall below the minimum requirement. This implies the 20% is the optimum replacement of cement with MHA.

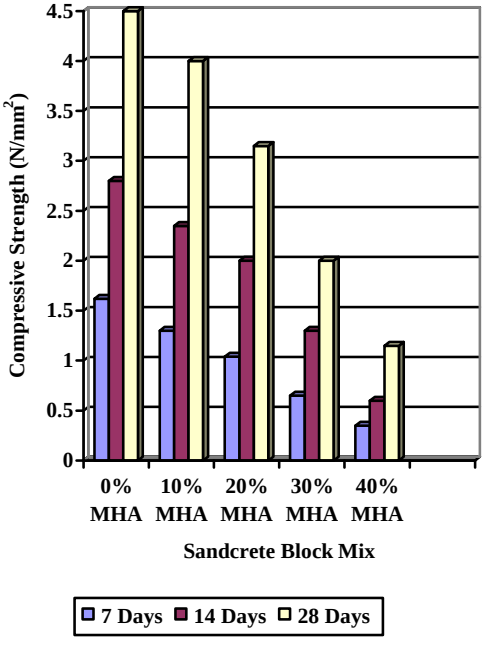

Figure -1: Compressive Strength of Sandcrete blocks

2.3 Water Absorption

The results of water absorption of the sandcrete block samples were presented in Table 2. The results show that the sample with 10% replacement of cement with MHA recorded the lowest water absorption of 5.00%. This could be as a result of densification of the sample due to pozzolanic reaction of OPC with MHA. At 20, 30 and 40% replacements of cement with MHA, the water absorption is higher than that of the control. However, the water absorption of all the specimens does not exceed the maximum allowed water absorption of 12% as specified by NIS 87 (2004).

Table 2. Water Absorption Test Result

Percentage Replacement	Water Absorption (%)
0% MHA, 100% OPC	5.25
10% MHA, 90% OPC	5.00
20% MHA, 80% OPC	5.85
30% MHA, 70% OPC	6.75
40% MHA, 60% OPC	8.25

3. CONCLUSIONS

Based on the findings of this research work, the following conclusions were drawn:

1. The millet husk ash sourced from Shendam, Plateau State, Nigeria is pozzolanic and could be used as partial replacement of cement in sandcrete blocks production.
2. The compressive strength of the sandcrete blocks for mixes increase with increase in curing age and decrease with increase in percentage replacement of cement with millet husk ash. 10 and 20% replacement of cement with Millet husk ash resulted to sandcrete blocks with acceptable compressive strengths.
3. The water absorptions of all the mixes were within the acceptable limits.

3. RECOMMENDATION

Partial replacement of cement with 20% millet husk ash is recommended for adoption in sandcrete block production.

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