International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 05 | May 2023 www.irjet.net p-ISSN: 2395-0072

OLIVE SEED ASH AS PARTIAL REPLACEMENT OF CEMENT IN SANDCRETE BLOCK

[1]S. I. Anowai, [2]T. S. Ketkukah, [3]M. Pam, [4]M.E. Gukas, [5]J.B. Rwang and [6]D.C. ANIESODO

[1] *Senior Lecturer, Department of Building, University of Jos, Nigeria*
[2] *Reader, Department of Civil Engineering, University of Jos, Nigeria*
[3] *Lecturer, Department of Quantity Surveying, University of Jos, Nigeria*
[4] *Lecturer, Department of Building, University of Jos, Nigeria*
[5] *Lecturer, Department of Quantity Surveying, University of Jos, Nigeria*
[6] *Student, Department of Building, University of Jos, Nigeria*

Abstract - *This research is therefore aimed at assessing the suitability of the use of olive seed ash (OSA) as partial replacement of ordinary Portland cement (OPC) in the production of sandcrete blocks. The olive seeds were completely burnt to ashes at a temperature of 600-700^{0}C in a kiln. Mix ratio of 1:6 (cement: sand) was used in this study. Water cement ratio of 0.45 was adopted in this study. OPC was partially replaced with OSA at 10%, 20% and 30%. The block samples were moulded and cured for 7, 28 and 56 days. The compressive strengths of the blocks were tested by crushing using compressive test machine. The compressive strengths of the blocks were observed to increase with increasing days of curing. Sandcrete block samples made with 10% and 20% replacements of OPC with OSA achieved compressive strengths of 3.53N/mm^2 and 3.00N/mm^2 respectively at 28 days and increased to 3.83N/mm^2 and 3.13N/mm^2 at 56 days respectively. These values satisfied the minimum compressive strength requirements of 3.45N/mm^2 for load bearing wall at 10% and 2.5N/mm^2 for non load bearing walls at 20% replacement levels of OPC with OSA. The densities of the blocks decreased as percentage replacements of OPC with OSA increases. The Blocks also satisfied the maximum water absorption requirement for sandcrete blocks. It is thus recommended that OPC should be partially replaced with 10% and 20% OSA in load bearing and non load bearing sandcrete blocks respectively.*

Key Words: Olive seed ash, sandcrete blocks, compressive strength, density water absorption.

1. INTRODUCTION

The high cost of cement used as binder in the production of mortar, sandcrete blocks and concrete has led to a search for its alternative. In addition to cost, high energy demand and emission of CO_2, which is responsible for global warming, the depletion of lime stone deposits are disadvantages associated with cement production. It is important to replace cement with other available materials at lowest possible costs [1]. The environmental effect of cement is most apparent in terms of its emissions of carbon dioxide (CO2), and this is one of the main impacts of cement production on an industrial scale.

Sandcrete block is a composite material made up of cement, sand and water which are moulded into diverse sizes [2]. Sandcrete blocks are made from a mixture of sand, cement and water and are produced in a mix ratio of 1:3, 1:4, 1:6, and 1:8 as the case may be depending on the mix ratio adopted.). However, sandcrete blocks are not affordable for low income earners [3.] Sometimes other ingredients such as pozzolanas are added to reduce the amount of expensive Portland cement.

Agricultural waste constitutes a sizeable proportion of the accumulated solid waste in many cities of the world. Attempts have been made by various researchers to convert solid waste to beneficial applications with a high level of success as a way of reducing solid waste accumulation [4].

Many studies have shown the ashes from agricultural wastes can be economically used as partial replacement of cement in sandcrete blocks. Anowai and Afunanya [5] investigated the suitability of Millet Husk Ash (MHA) in hollow blocks production. Cement was partially replaced with MHA in varying percentages of 0, 10, 20 and 30% by weight. It was found that cement could be partially replaced with up to 20% MHA in sandcrete block production. Another research by Anowai et.al, [6] also found Maize Cob Ash can be used as partial replacement of ordinary Portland cement (OPC) in the production of Sandcrete Blocks. Afolayan, Oriola, Moses and Sani [4], investigated the effect of egg shell ash (ESA) on the properties of sandcrete blocks and found that cement could be partially replaced with ESA in sandcrete block production. Aginam, Onodagu and Nwakaire, Chidozie [7] investigated the use of breadfruit stem ash as a partial replacement of cement in sandcrete and recommended that not more 10% of cement should be replaced with breadfruit stem ash. Similarly, Sangeetha [8] found the optimum replacement level of OPC with rice husk ash 15 -20%.

Olive seeds are part of agricultural waste that litters the environment. In the ever increasing endeavors to convert waste to wealth, the value of converting olive seed to beneficial use becomes an idea worth investigating. Olive Seeds are found abundantly at various farms across Nigeria are treated as waste materials. The olive seed ash is obtained by the combustion of Olive Seed.

This Study is aimed at assessing the suitability of Olive seed ash as partial replacement of cement in sandcrete block by comparing the compressive strengths and water absorptions at different percentages of replacement.

2. MATERIALS AND METHODS

The main constituent materials used in this research work are cement, Olive seed ash, sand and water. Ordinary Portland Cement (OPC) used in this study was "BUA" brand of grade 43 cement, conforming to [9]. The specific gravity of the cement was found to be 3.15

The olive seeds used in this study was sourced from Bwonpe village of Ampang west, Plateau state, Nigeria.. The seeds were sundried and burnt under a controlled temperature in a kiln at temperature of approximately 600 ˚C to 700˚C to obtain the ash. The ash obtained was sieved through a 150*u*m sieve before use. Chemical analysis and specific gravity test were performed on the ash. The chemical analysis of the sample was carried out using Energy Dispersive X-ray Fluorescence Spectrometer (EDXRF). The apparent specific gravity of the OSA was 2.75, which was less than that of cement.

The fine aggregate used was river sand passing 4.75*mm* sieve. Sieve analysis result of the sand show that the sand falls under zone 2 in accordance with [10]. The specific gravity of the fine aggregate was found to be 2.72. The water used for this research was borehole water which is fit for drinking and conforming to [11].

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 the sandcrete blocks production. Cement was partially replaced with Olive seed ash at varying percentages of 0, 10, 20 and 30% by weight. Water cement ratio of 0.5 was adopted. The blocks were molded and cured for 7, 14 and 28 days. The mixing procedure was done in three stages. In the first stage, all binders (cement, Olive seed ash) were weighed and mixed manually until all the constituents mixed uniformly. The second stage involves mixing the binder with the aggregate for about 5 minutes until a homogenous mix is achieved. At the final stage, measured water is added onto the sandcrete mix. After mixing, the sandcrete was poured into an electric moulding machine and well vibrated. After vibration, the blocks were removed from the mould and cured after 24 hours by method of sprinkling in accordance with [12]. This involves wetting of blocks regularly with water so as to permit proper hydration. 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 [12]. Water absorption test was also carried out on the block samples after 28 day curing in accordance with [12].

3. RESULTS AND DISCUSSION

3.1 Chemical Composition of Olive Seed Ash

The result of chemical analysis result of Olive seed ash is presented in Table 1. The result showed that the sum of the percentages of Silicon Oxide, Aluminium Oxide and Iron Oxide (SiO_2+Al_2O_3+Fe_2O_3) is 72.54%. This is greater than the minimum sum of 70% specified by [13] for pozzolanas. This indicates that olive seed ash is a good pozzolanic material and can be used as partial replacement of cement in sandcrete block production.

Table 1: Olive Seed Ash Chemical Composition and Percentage content.

Chemical Constituents	Percentage	ASTM C 618 Requirement (%)
SiO_2	65.17	
Al_2O_3	4.25	
Fe_2O_3	1.50	
$SiO_2 + Al_2O_3 + Fe_2O_3$	70.92	70 minimum
CaO	6.17	

MgO	4.15	5.0 maximum
SO_3	3.78	5.0 maximum
K_2O	8.28	
Na_2O	1.27	1.5 maximum
PK_2	3.81	

3.2 Compressive Strength of the Blocks

Figure 1 shows the result of the compressive strength development of sandcrete blocks produced with Olive Seed Ash. The result shows the compressive strengths of the bblocks at curing durations of 7, 28 and 56 days. Based on Figure 2, the compressive strength of the blocks increased with increase in curing duration and decreased with increase in percentage replacement of OSA.

At 0% replacement of OPC with OSA, the compressive strengths were 3.17N/mm², 3.82N/mm² and 3.98N/mm² at 7 days, 28 days and 56 days curing durations respectively. At 10% percentage replacement, the compressive strengths were 2.76N/mm², 3.53N/mm² and 3.73N/mm² at 7 days, 28 days and 56 days curing durations respectively. At 20% percentage replacement, the compressive strengths were 2.35N/mm², 3.00N/mm² and 3.13N/mm² at 7 days, 28 days and 56 days curing durations respectively. At 30% percentage replacement, the compressive strengths were 1.87N/mm², 2.31N/mm² and 2.52N/mm² at 7 days, 28 days and 56 days curing durations respectively.

The results showed that the blocks produced with 0% OSA achieved the required strengths of 3.45N/mm² for load bearing walls and 2.5N/mm² for non-load bearing walls as specified by [13] for sandcrete block production at 28days of curing. Sandcrete block samples made with 10% and 20% replacements of OPC with OSA achieved compressive strengths of 3.53N/mm² and 3.00N/mm² respectively at 28 days and increased to 3.73N/mm² and 3.13N/mm² at 56 days respectively. These values satisfied the minimum compressive strength requirements of 3.45N/mm² for load bearing wall at 10% and 2.5N/mm² for non load bearing walls at 20% replacement levels of OPC with OSA.

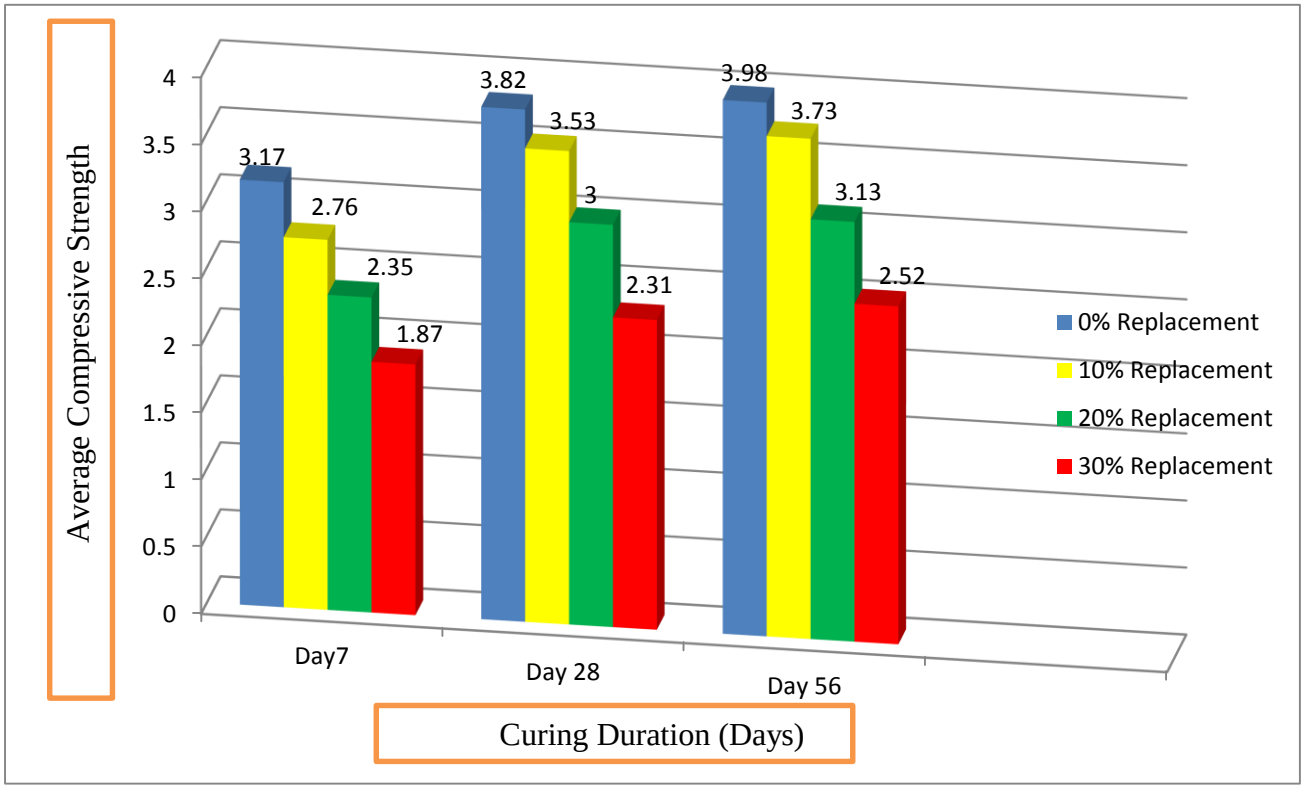

Figure 1: Compressive strengths of sandcrete blocks at 7, 28 and 56 days of curing

3.3 Density of Sandcrete Blocks

The densities of the block samples tested are presented in Figure 3. The result shows that the more quantity of cement present in the blocks the more their densities. This implies that increase in the percentage replacement of OSA results in the corresponding decrease in its density. Based on the results, with 0% replacement of OPC with OSA gave the highest density of 2317.8kg/m^3 and the density decreased progressively as the percentage replacement of OPC| with OSA in the blocks increased.

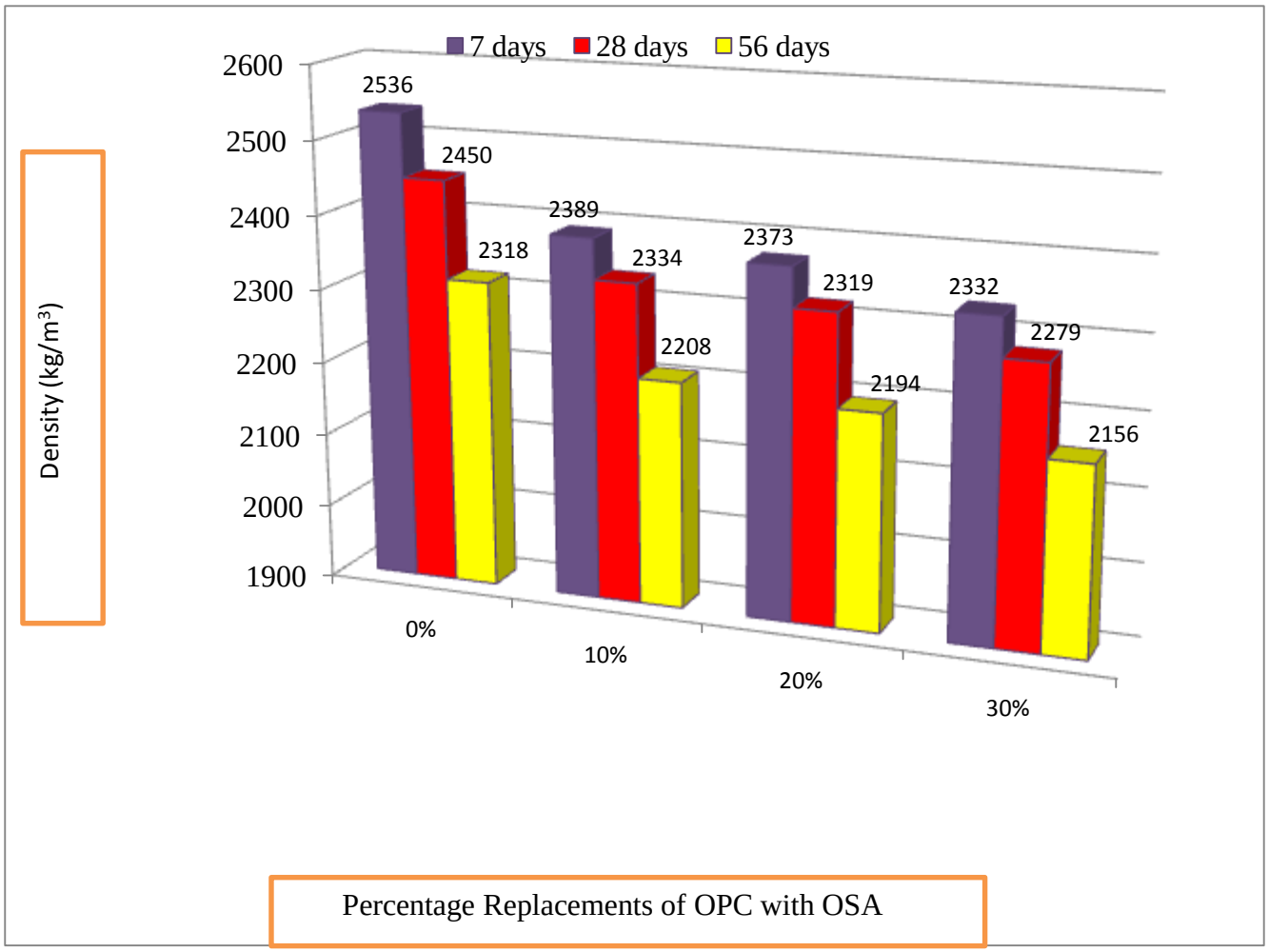

Figure 2: Density Test Representation in kg/m^3

3.4 Water Absorption of Sandcrete Blocks

Water absorption test results of the blocks at different percentage replacements of OPC with OSA are presented in Figure 4. Nigerian Industrial Standard [13] that water absorption in sandcrete blocks shall not be greater than 12%. The result showed that the water absorption of the blocks with 0%, 10%, 20% and 30% replacements of OPC with OSA are 6.37%, 7.59%, 8.5% and 9.25% respectively. The results showed that the water absorption of the blocks increased with increase in the percentage replacement of OPC with OSA. Although, all the blocks have their water absorptions below the maximum value specified by [13] the specimen with 0% OSA gave the lowest water absorption of 6.37%.

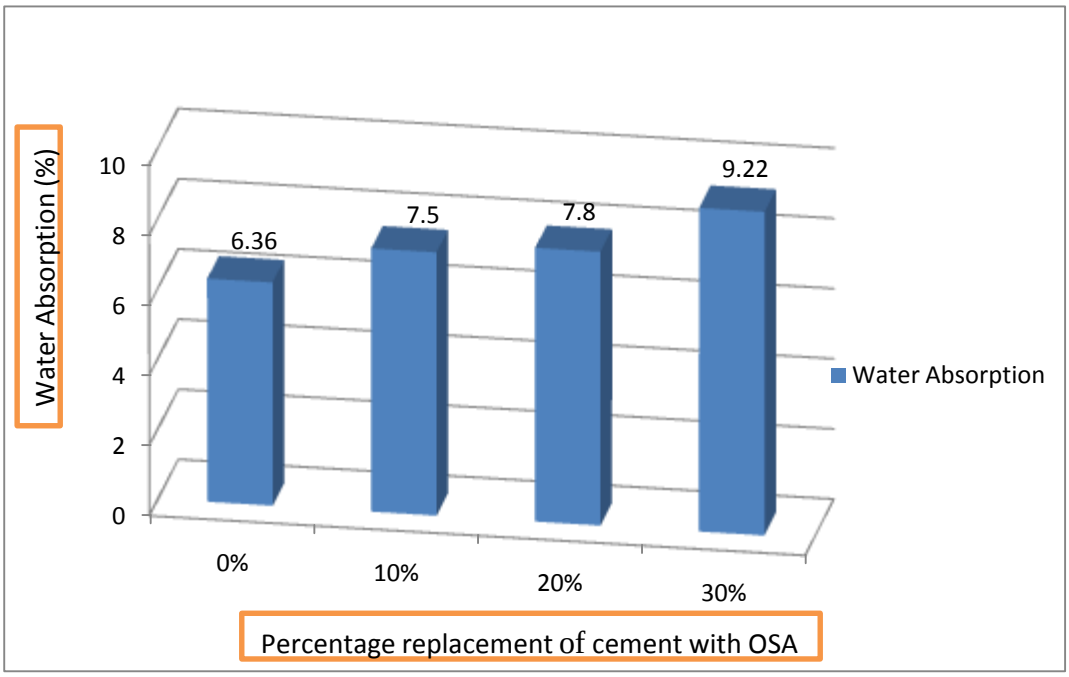

Figure 4: Average Water Absorption of Sandcrete Blocks at end of 28 days

4. SUMMARY OF FINDINGS

Based on the results of various tests carried out on the sandcrete block samples, the following conclusions were made:

1. Olive seed ash is pozzolanic and suitable for use as partial replacement of cement in sandcrete block production.
2. The density of sandcrete blocks decrease with increase in the percentage replacement of OPC with OSA.
3. Sancrete blocks with 10% replacement of OPC with OSA satisfied the minimum compressive strength requirements of 3.45N/mm^2 for load bearing at 28 days while Sancrete blocks with 10% replacement of OPC with OSA satisfied the minimum compressive strength requirements of 2.50N/mm^2 for load bearing at 28 days
4. The water absorption of the blocks increased with increase in the percentage replacement of OPC with OSA. However, all the sample satisfied the maximum water absorption requirement

5. CONCLUSION

Olive seed ash is found to be pozzolanic and can be used as partial replacement in sandcrete block production. Cement can be partially replaced with Olive seed ash at 10% and 29% in sandcrete blocks to be used for load bearing and non load bearing walls respectively.

REFERENCES

[1] Tayeh, B. A., Nyarko, M. H., Zeyad, A. M & Al-Harazin, S.Z.(2021). Properties and Durability of Concrete with Olive Waste Ash as a Partial Cement Replacement.*Advances in Concrete Construction*. 11(1), 59-71

[2] Odeyemi, S. O. , Akinpelu, M. A., Atoyebi, O. D. & Orire, K. J. (2018). Quality assessment of sandcrete blocks produced in Adeta, kwara state, Nigeria, *Nigerian Journal of Technology*. 37(1), 53-59.

[3] Sholanke, A. B., Fagbenle, O. I, Aderonmu, A. P &Ajagbe, M. A. (2015).Sandcrete Block and Brick Production in Nigeria - Prospects and Challenges.*International Journal of Environmental Research*. 1(4), 1-17.

[4] Afolayan, J. O., Oriola F.O.P., Moses, G & Sani J.E. (2017). Investigating the Effect of Eggshell Ash on the Properties ofSandcrete Block.*International Journal of Engineering and Applied Sciences (IJEAS)*. 4(12), 43-54.

[5] Anowai, S.I & Afunanya, J. E. (2017).Millet Husk Ash as Partial Replacement of Cement in Sandcrete Blocks.*International Research Journal of Engineering and Technology (IRJET)*. 4(7), 677-680

[6] Anowai, S. I., Ishaya, A. A., Zakka, P.W., Yahaya, A. M., & Oyelade, O.M. (2019). Suitability of Maize Cob Ash as a Partial Replacement of Cement in Sandcrete Blocks. *International Journal of Environmental Studies and Safety Research, 4*(3), 25-30.

[7] Aginam, C. H., Onodagu, P. D. and Nwakaire, Chidozie (2013). Breadfruit stem ash as a partial replacement of cement in sancrete block making. *International Journal of Engineering Research and Applications*, 3(4), 60-65.

[8] Sangeetha, S.P. (2016). Rice Husk Ash Sandcrete Block as Low Cost Building Material, *International. Journal of Engineering Research and Application*, 6(6), 46-49.

[9] British Standards Institution (1991). *BS 12. Specification for Portland Cements:* London, England: BSI.

[10] British Standards Institution (1992). *BS 882. Specification for Aggregates from Natural Sources for Concrete.* London, England: BSI.

[11] British Standards Institution 1980). *BS 3148.* Methods *of Tests for Water for Making Concrete*. London, England: BSI.

[12] Nigerian Industrial Standard (2004). Nigerian Industrial Standard Standard for sandcrete blocks. Nigerian Industrial Standard approved by The Standard Organisation of Nigeria (SON), NIS:87.

[13] American Society for Testing and Materials (2000). Specifications for Pozzolanas. ASTM International, USA, ASTM C618.