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Study Of Compressive Strength Characteristics Of Hollow Sandcrete Blocks Partially Replaced By Saw Dust Ash

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Abstract: - The high cost of conventional Building materials is a major factor affecting housing delivery in Nigeria. This has necessitated research into alternative materials of construction. This paper presents the results of an investigation carried out on the use of Saw Dust Ash(SDA) as partial replacement for Ordinary Portland Cement(OPC) in sandcrete hollow blocks, in order to determine the optimum quantity of SDA in percentage by weight of OPC, so as to effectively reduce the cost of Building production. The percentage of SDA is in gradation of 0%, 5%, 10%, 15% and 20%, two mix ratios (1:6 and 1:8) were used, and the blocks produced were tested for Density and Compressive strength. The results of the tests showed that as the percentage of SDA increased, Density and Compressive strength decreased. At 28days the Compressive strength of blocks with 10% SDA replacement are 2.2N/mm^2 and 2.0N/mm ^{2} which satisfy the requirement. specified by the National Building Code (2006). It was concluded that up to 10% SDA replacement can be used for non-load bearing walls for 1:8 mix at 28days curing age. Also, up to 10% replacement for 1:6 mix can be used for load and non-load bearing walls.

Keyword: *Sawdust Ash, Compressive Strength, Density*

I. INTRODUCTION

The shortage of building materials and the escalating prices of those available are responsible for the acute shortfall in the provision of adequate housing in all parts of Nigeria both in urban and rural areas (Lasisi *et al.,* 1990). According to Osunade and Fajobi (2000), In Nigeria today as in most other developing countries of the world, housing programmes are being executed with the intensive use of cement to the detriment of traditional building materials, the resulting effects of this practice include the high cost of building and the non-realization of governmental housing objectives.

There is no gainsaying that the cost of building materials affects significantly the cost, rate and methods of housing provision. The higher the cost of building materials, the higher the cost of housing construction and the fewer the number of people who can afford their desired houses (Onibokun and Ogbuozobe, 1985). According to Olanipekun *et al.* (2005), one of the suggestions for cutting down conventional building material costs has been the sourcing, development and use of alternative, non-conventional local construction materials including the possibility of using some agricultural wastes and residues as constructional materials. According to Folagbade (1998), Housing shortages in the developing countries have been on the increase, in part, because of the inability of government to develop relevant policies in relation to materials and construction techniques .Policies have been tailored towards the standards used in most of the developed countries, but which bear no relationship to the needs of the people and what they can afford. Since the 1976 United Nations (UN) Conference on human settlements in Vancouver, housing literature has become replete with experts reports recommending the use of traditional materials, based on its cheapness, availability, ease of production with little capital, energy consumption, and the associated level of technology.

This most unsatisfactory situation is still getting worse due to the impact of population growth and urbanization. There has been a remarkable increase in recent years in the rate of growth of population together with a steady drift of population from the rural to the urban centres. There has been an increase in the number of professional, administrative and technical people as a result of improvement in Educational standards. There has been an improvement in the general level of prosperity, incomes, and living conditions of people, with its attendant increase in people's expectations. All these have led to people demanding more and better houses. Supply on the other hand, for a number of reasons, has not kept pace with this demand. In the urban areas the increase in demand, especially due to the rural urban migration, cannot be satisfied by the rate of construction. In the rural areas, the problem is one of quality – a problem of finding the means to provide houses which are relatively cheap and within the means of the rural folk and yet of sufficiently high quality to satisfy certain basic requirements(Poju,1985)

One of the ways of reducing cement cost in concrete is by partially replacing it with some cheaper materials referred to as pozzolana. Waste material generated from industrial and agricultural activities can be recycled in to new building materials. It is against this background that effort is made towards partial replacement of Ordinary Portland Cement (OPC) with Saw-Dust Ash (SDA), as a pozzolana. Pozzolana is defined by the

American society for testing materials (ASTM C 618-1978) specification as a siliceous and aluminous material which, in itself possess little or no cementitious value but in fine form and in the presence of moisture or water, chemically reacts with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties.

Sawdust is an organic waste resulting from the mechanical milling or processing of timber (wood) into various shapes and sizes. The dust is usually used as domestic fuel. The resulting ash known as Sawdust Ash (SDA) is a form of pozzolana.

Reviews of past works have shown that research investigations have been carried out on the use of Saw Dust Ash (SDA) in building Construction. Some of the issues that have been researched into include; optimization of sawdust ash stabilization of adobe bricks (Fajobi and Adewumi, 2006); effect of wood ash and sawdust admixtures on burnt laterite-clay bricks (Emmanuel, 2008); effect of sawdust addition on thermal and physical properties of Ikere - Ekiti and Ikeji –Arakeji Clay Blends (Adegoke and Ijagbemi, 2006); properties of SDA – OPC concrete A preliminaries assessment (Summaila and Job, 1999); etc.

The possibility of using SDA as partial replacement of OPC need to be investigated for confident use of these materials. The study therefore aimed at determining the optimum quantity of SDA in percentage by weight of OPC so as to effectively reduce the cost of building production. The main objective is to encourage the use of these 'seemingly' waste products as construction material in low-cost housing.

II. METHODOLOGY

The study of Compressive strength of Hollow Sandcete blocks partially replaced by Saw Dust Ash was carried out as a laboratory experimental work at Building department laboratory of the Federal Polytechnic Ede, Osun State, Nigeria. It discusses the materials and equipment used, collection and sourcing of the materials, basic laboratory tests and experimental procedures for the main aspect of the work.The performance characteristics studied were: Compressive strength and Density of the Sandcrete blocks. For each of these characteristics the experimental set up was 5x2x2 factorial arrangement with (3) replicates. The factors are: percentage of Sawdust Ash at five levels (0%, 5%, 10%, 15% and 20%), mix ratios at two levels (1:6 and 1:8) and curing days at two levels (7 and 28). Three replicates were used for the work. The methodology is a combination of empirical and graphical relationships. Principles of full factorial experimental design were used in the treatment of the data generated from the laboratory tests.

2-1 Material sampling

The basic components of the materials used were Saw-Dust Ash (SDA), Ordinary Portland Cement (OPC), Sand and Water. The Saw-dust was collected manually from the saw mill behind Mapo-Arogun Grammer School, Oke-Gada, Ede, Osun State, Nigeria. The Cement was Ordinary Portland Cement (OPC) whose properties are believed to conform to the requirements of BS EN197-1 (2000).The Sand was collected from the river at Oke Gada in Ede and the range of size of the sand used are those that passed through 5mm BS Sieve. Portable water that is free from organic matter of any kind was used for mixing.

2-2 Preparing the test samples

The blocks were manufactured with the use of manual method of moulding with 6'' (450mm x 225mm x 150mm) mould. Two-mix ratios (1:6 and 1:8) cement-sand ratio were used, varying cement replacement with sawdust ash amounting to 0%, 5%, 10%, 15% and 20% were used. The Sawdust was burn to ash by open burning method using .The SDA was sieved using a 300micrometer sieve. Three cubes were cast for Compressive strength, and Density tests were done before crushing. For the purpose of this study, sixty (60) numbers of 450mm x 150mm x 225mm sandcrete blocks was produced.

2-3 Determination of the Compressive strength

The compressive strength were done by crushing Sandcrete blocks of sizes 450mm x 150mm x 225mm on a 1000kN capacity ELE Compression machine. Soft boards of 10mm thickness were used as packing materials between the blocks and the platens of the machine. The blocks were well centered under the compression machine before the load was applied. The test was done for 7 and 28days

2-4 Curing of the specimens

The block specimens were stored in a place free from vibration, not exposed to direct sunlight, and then subjected to curing. The curing was done by wetting the blocks with water twice in a day.

III. TESTS RESULTS AND DISCUSSION

3-1Density of Sandcrete block

In all cases, the density of the Sandcrete blocks produced decreased with increase in the percentage replacement of conventional Sandcrete blocks with SDA. There was decrease in the density as the curing age increases, and the values for mix ratio 1:8 are lower than mix 1:6 as shown in fig. 1 and fig. 2. At 0% level of SDA substitution, the density of the blocks at 7 days and 28 days curing was (3100, 2003)kg/m^3 and (2139 , 1777)kg/m^3 for mix ratios 1:6 and 1:8 respectively. At 5 % levels of SDA substitution, for 7 and 28 days the density decreased respectively to (3062, 1989) kg/m3 and (2106 , 1972)kg/m^3 respectively for mix ratios 1:6 and 1:8 while at 20% level of SDA substitution for 7 and 28days it was (2930,1935)kg/m^3 and (2068,1937)kg/m^3 respectively for mix ratios 1:6 and 1:8. For all cases considered, the minimum density obtained was 1935 and 1937kg/m^3 for mix ratios 1:6 and 1:8 respectively at 28 days. This is above the minimum value of 1500kg/m^3 recommended for first grade sandcrete blocks by NIS 087(2000)

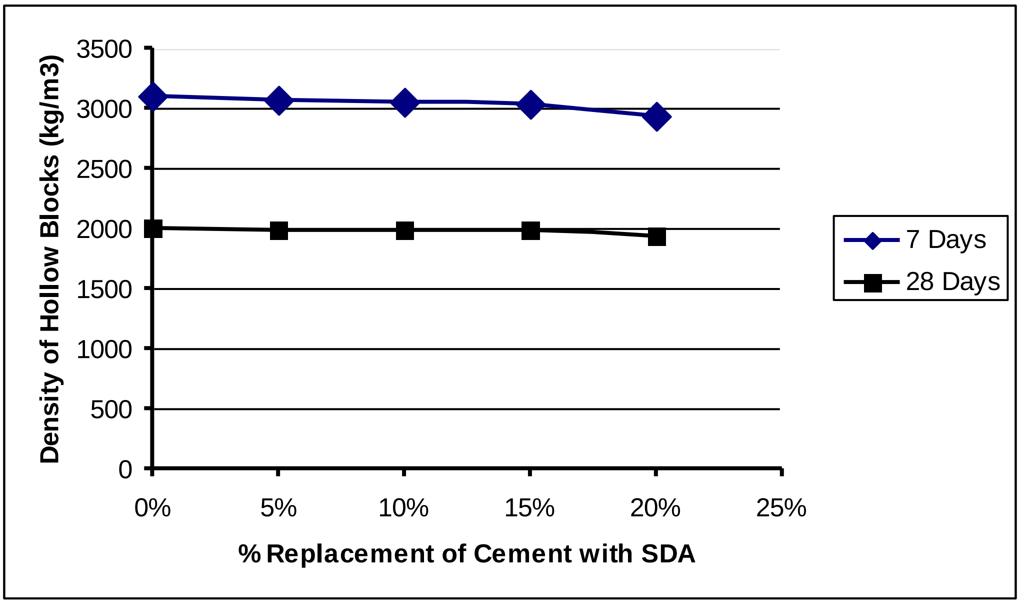

Figure 1: Density vs. % replacement at 7 and 28 days curing, for mix ratio 1:6

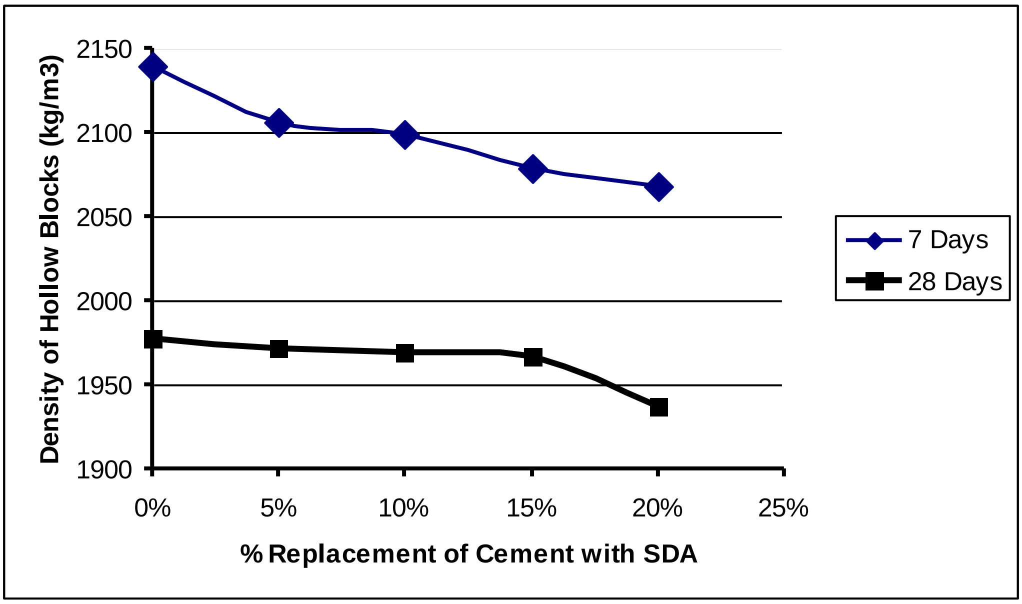

Figure 2: Density vs. % replacement at 7 and 28 days curing, for mix ratio 1:8

3-2 Compressive strength

The results showed that the compressive strength of the Sandcrete hollow blocks decreased with increase in the percentage substitution of SDA content. The results of the compressive strength are presented in figure 3 and figure 4 respectively. The compressive strength of sandcrete blocks made with 100% OPC (control) for mix 1:6 and 1:8 at 7days and 28days were $2.82N/mm^2$ and $3.66N/mm^2$, $2.46N/mm^2$ and $3.39N/mm^2$ respectively. The compressive strength obtained at 28days for both mix are higher than those obtained at 7days but met the required minimum standard of $2.0N/mm^2$ specified by National Building Code (2006) for load bearing walls.

The result obtained for sandcrete blocks with 5% SDA content shown in fig 1 and 2 indicated that the compressive strength ranges from $2.35N/mm^2$ to $2.92N/mm^2$ for mix 1:6 at 7days and 28days respectively, then $1.90N/mm^2$ to $2.60N/mm^2$ for mix 1:8 at 7days and 28days respectively. Compressive strength obtained for blocks with 10% SDA content ranges from $1.92N/mm^2$ to $2.19N/mm^2$ and $1.65N/mm^2$ to $2.00N/mm^2$ for both mix at 7days and 28days respectively, the strength at 28days for both mix met the minimum required standard recommended by the National Building Code (2006) for non-load bearing walls.

The results for 15% and 20% SDA content for both mixes followed a similar pattern with compressive strength ranging from $1.47N/mm^2$ - $1.88N/mm^2$, $1.20N/mm^2$ - $1.42N/mm^2$ for 1:6 mix at 7days and 28days, $1.11N/mm^2$ - $1.49N/mm^2$, $1.00N/mm^2$ - $1.20N/mm^2$ for 1:8 mix at 7days and 28days respectively. These results did not meet the required standard of $2.0N/mm^2$ recommended by the National Building Code (2006) for non-load bearing walls.

Also, the compressive strength obtained by 1:6 mix is higher than that of 1:8 mix at 7days and 28days respectively as shown in figure 1 and figure 2 and it is therefore advisable to use 1:6 mix for the production of Hollow Sandcrete Blocks.

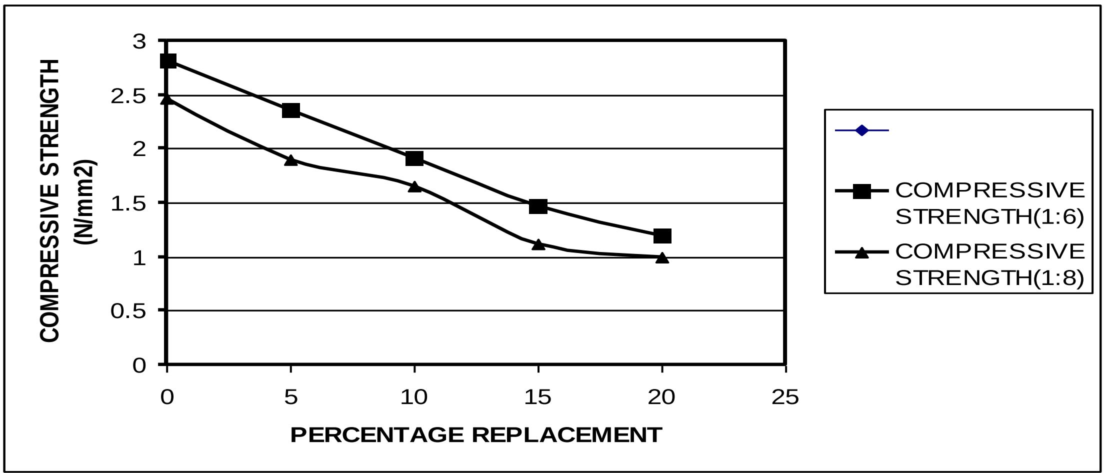

Figure 3: **a chart showing the Compressive Strength Hollow Sandcrete Blocks with Cement partially replaced with Sawdust Ash for mix ratio 1:6 and 1:8 at 7days curing age**

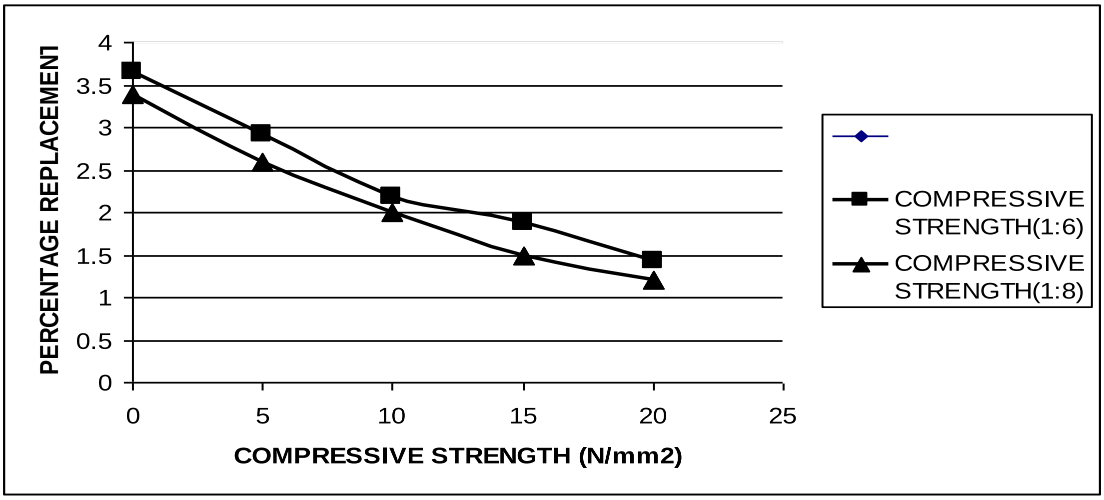

Figure 4: **a chart showing the Compressive Strength of Hollow Sandcrete Blocks with Cement partially replaced with Sawdust Ash for mix ratio 1:6 and 1:8 at 28days curing age**

IV. CONCLUSION AND RECOMMENDATION

A comparative study of Sandcrete blocks using SDA as partial replacement for cement has been carried out. Generally, the compressive strength and density decreased as the percentage of SDA increased. The compressive strength increases as the curing age increases while density decreases as curing age increases. The compressive strength of sandcrete hollow blocks produced by mix 1:6 was higher than those of mix 1:8

From the foregoing it is recommended that only up to 10% of SDA replacement for 1:8 mix should be used for non-load bearing walls while 10% of SDA replacement for mix 1:6 is adequate for use in sandcrete hollow blocks for load and non-load bearing walls.

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