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Study of Compressive Strength of hollow Sandcrete Blocks Stabilized with Bamboo Leaf 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 investigates the use of Bamboo Leaf Ash (BLA) as partial replacement for Ordinary Portland Cement (OPC) in Sandcrete hollow blocks in order to determine the optimum quantity of bamboo leaf ash in percentage by weight of OPC so as to effectively reduce the cost of building production. Some units of Sandcrete hollow blocks were produced by replacing the cement content with 5% to 20% by weight of BLA using manual method. The blocks produced were tested for compressive strength. The result indicated that the compressive strength at 28days are 4.43N/mm^2, 3.50N/mm^2, 2.64N/mm^2, 2.28N/mm^2, 1.72N/mm^2 for 1:6 mix and 3.98N/mm^2, 3.25N/mm^2, 2.37N/mm^2, 1.79N/mm^2 and 1.45N/mm^2 for 1:8 mix for 0%,5%, 10%, 15% and 20% BLA content respectively. At 28days, the compressive strength of blocks with 10% BLA replacement are 2.37N/mm^2 and 2.64N/mm^2 respectively, whereas the required standard specified by National Building Code (2006) for load and non-load bearing walls are 2.5N/mm^2 and 2.0N/mm^2. It was concluded that for Sandcrete blocks, 1:6mix ratio at 28days, up to 10% replacement can be used for load bearing walls and up to 15% replacement can be used for non-load bearing wall. For 1:8 mix at 28days curing age, up to 5% replacement can be used for load bearing walls and up to about10% replacement can be used for non-load bearing walls.***

Keywords: Bamboo leaf ash(BLA), Compressive strength, Mix ratio, Sandcrete blocks, OPC, Curing days.

1. Introduction

Housing for the poor remains a major challenge for most developing nations like Nigeria where majority of the population still live in sub-standard houses. Materials used in the country are either imported or manufactured with high technology in large scale industries. The high demand for foreign exchange, capital-intensive nature and huge overhead costs in the manufacturing and procurement of these materials consequently translate into high cost of the finished building materials (Opoko, 2006). Building material constitutes an essential component in housing and other types of construction as well as in the supportive infrastructure facilities. According to Aribisala (1990), building materials account for about 60% of the total building cost. Kolawole and Olaoti (2006) opined that, one reason for high construction cost in the country is the inability of the construction industry to fully utilize inexpensive abundant local raw material for construction. For some time now, the Nigerian government has been clamouring for the use of local materials in the construction industry to limit costs of construction. There has therefore been greater call for the sourcing and development of alternative, non-conventional local construction materials (Ndoke, 2006).

The need to use local materials for building units cannot be overemphasized, the growth of urban population in Nigeria is anticipated to double within the next one and half decades. This together with the increasing standard of living will certainly create a huge need for proper housing. The high costs of building materials in Nigeria have gingered researchers to develop local building materials, which could be affordable to majority of Nigerians (Adesanya, 2000). There is a continuous increase in the cost of the conventional items of Building materials particularly cement, this therefore calls for an urgent investigation into the possibility of using local material as substitute.

The local demand for cement in the country is in the region of 18million tons annually, only 6 to 6.5 million tons are produced locally. Thus 11.5million tons are imported to meet up these deficits. The consequence of these is that the cost of cement and other related materials are high in the country (Dadu, 2011). One of the ways of reducing cement cost is by partially replacing it with some cheaper materials referred to as pozzolana. A pozzolan is defined as a siliceous and aluminium material which in itself possesses little or no cementing property but will in a finely divided form, and in the presence of moisture chemically reacts with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties (Shetty, 2002).Over the years, many waste materials like fly ash and ashes produced from various agricultural wastes such as rice husk ash, corn cob ash, palm oil waste, groundnut husk ash, bamboo leaf ash have been tried as pozzolana or alternative cementitious material, but the use of Bamboo leaf ash as a pozzolan in Sand Crete blocks is scarce in literature hence this study.

2 Methodology

The study of Compressive strength of Hollow Sandcrete blocks partially replaced by Bamboo Leaf Ash (BLA) 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. Compressive strength was determined using 5x2x2 factorial arrangement with (3) replicates. The factors are: percentage of BLA 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). 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 materials used were Bamboo Leaf Ash (BLA), Ordinary Portland Cement (OPC), Sand and Water. The Bamboo leaf was collected from the bush along Akoda road, Ede. The Bamboo leaf was burnt to ash by open burning method. The BLA was then sieved using 300 micrometer sieve. The Cement was obtained from the market and was those produced by the West Africa Portland Cement Company since their products are assumed to conform to the requirements of BS197-1:2000 for Ordinary Portland Cement.

The sand used was gotten from Ede, and the range of size of the sand used were those that passed through 5mm BS Sieve. Fresh, colourless, odourless and tasteless 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 BLA amounting to 0%, 5%, 10%, 15% and 20% were used. The Bamboo leaf was burn to ashes by open burning method. The BLA was sieved using a 3=00micrometer sieve. Three replicate was cast for Compressive strength, and 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 was 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.

3. Tests Results and Discussion

3.1 Compressive strength

The results showed that the compressive strength of the Sandcrete hollow blocks decreased with increase in the percentage substitution of BLA content and it increases with increase in curing age. The results of the compressive strength of sandcrete hollow blocks are presented as shown in Tables 1 to 4. The

compressive strength of sandcrete blocks for mix ratio 1:6, percentage replacement (0% -20%) is (3.66, 2.92, 2.19, 1.88 and 1.42) N/mm^2 while for mix ratio 1:8 is (3.25, 2.26, 1.99, 1.72 and 1.18) N/mm^2.The result revealed that up to 5% for mix ratio 1:6, and 0% BLA replacement for mix ratio 1:8, can be used for load bearing walls. The result at 28days for mix ratios 1:6 and 1:8, for percentage replacement (0% - 20%) are (4.43, 3.50, 2.64, 2.28 and 1.72) N/mm^2 and (3.98, 3.25, 2.37, 1.72, 1.45) N/mm^2.The result revealed that for mix ratio 1:6 up to 10% BLA replacement can be used for load bearing walls, while up to 15% can be used for non-load bearing walls according to the standard. The result for mix ratio 1:8 reveal that up to 5% BLA replacement can be used for load bearing wall while up to 10% can be used for non-load bearing wall.

Table 1: Compressive strength of sandcrete hollow blocks partially replaced with bamboo l ash for mix ratio 1:6 at 7 days curing age.

Percentage Replacement (%)	Crushing Loads (kN)			Average Crushing Loads (kN)	Compressive Strength N/mm^2
0	120	130	140	130	3.66
5	100	108	110	106	2.92
10	80	86	90	85	2.19
15	60	70	66	65	1.88
20	50	56	56	54	1.42

Table 2: Compressive strength of sandcrete hollow blocks partially replaced with bamboo leaf ash for mix ratio 1:8 at 7days curing age.

Percentage replacement (%)	Crushing Loads (kN)			Average Crushing Loads (kN)	Compressive Strength N/mm^2
0	118	100	110	109	3.25
5	80	84	88	84	2.26
10	70	74	76	73	1.99
15	60	64	66	63	1.72
20	42	42	46	43	1.18

Table 3: compressive strength of sandcrete hollow blocks partially replaced with bamboo leaf ash for mix ratio 1:6 at 28days curing age.

Percentage Replacement (%)	Crushing Loads (kN)			Average Crushing Loads (kN)	Compressive Strength N/mm^2
0	160	164	166	163	4.43
5	132	126	130	129	3.50
10	98	96	98	97	2.64
15	84	82	86	84	2.28
20	66	60	64	63	1.72

Table 4: compressive loads of sandcrete hollow blocks with cement partially with bamboo leaf ash for mix ratio 1:8 at 28 days curing age.

Percentage Replacement (%)	Crushing Loads (kN)			Average Crushing Loads (kN)	Compressive Strength N/mm^2
0	146	150	144	147	3.98
5	110	120	130	120	3.25
10	90	84	88	87	2.37
15	68	64	66	66	1.79
20	50	56	54	53	1.45

4 Conclusion

A study of Sandcrete blocks using BLA (Bamboo leaf ash) as partial replacement for cement has been carried out. Generally, the compressive strength decreased as the percentage of BLA increased. The compressive strength increases as the 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 BLA replacement for mix ratio 1:6 can be used for loadbearing wall, while 15% of BLA replacement can be used for non-load bearing wall. For mix ratio 1:8, Up to 10% BLA replacement can be used for non-load wall, while 5% can be used for load bearing wall.

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