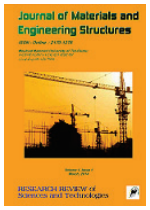

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Research Paper

The effects of production methods on the compressive strength of hollow sandcrete blocks

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ABSTRACT

The high demand for sandcrete block for the development of physical infrastructures in Nigeria makes it important in building and construction industry. This research assessed three local methods of producing sandcrete blocks of sizes nine (9'') and six (6'') inches respectively. The methods used in producing the blocks were manual compaction, hand ramming and power operated method. Mix ratio of 1:9; a head pan of cement to nine head pans of sharp sand was used in all the methods. The materials (sand & cement) were thoroughly mixed until a homogenous mix with uniform color was obtained. Curing was done by sprinkling water on the specimens three times daily for 28 days and the compressive strength of the blocks was determined on the 7th, 14th, 21st, 28th days respectively. The study revealed that compaction has greater effect on the compressive strength of sandcrete blocks in the sense that blocks produced using vibrating machine has the highest compressive strength amongst the three methods.

1 Introduction

Blocks are those building unit used in the construction of walls and partitions. Sandcrete block is a composite material made up of cement, sand, water, molded into different sizes [1]. Sandcrete blocks can be made either in solid and hollow rectangular types. They are of sizes and weight that can be easily handled by the bricklayer with the facing surface layer than that of a brick but conveniently dimensioned. The most commonly available sizes are 450mm x 225mm x 225mm and 450mm x 150mm x 225mm. Sandcrete blocks are available for the construction of load bearing and non-load bearing structures [2]. According to building specifications, load bearing blocks must have appreciable width and adequate crushing load in order to perform satisfactorily while in use. Sandcrete blocks also participate in the task of transforming the actual load from the overlaying structural element to the foundation. In this case, the load bearing walls are those walls

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acting as supports for the other structural members (slabs and beams) and transfer all loads from superstructure to the underlying foundation [1].

Hollow block is a composition of usually (1:6) mix of cement and sharp sand with the barest minimum of water mixture, and in some cases admixture, molded and dried naturally. Nigerian Industrial Standard defines sandcrete block as a composite material made up of cement, sand and water, molded into different sizes [1]. It is widely used in Nigeria and other countries like Ghana as walling unit. The quality of blocks produced however, differs from each industry due to different methods employed in the production and the properties of the constituent materials used respectively.

Sandcrete blocks constitute a unique class amongst man-made structural component for building in civil engineering work. For example in buildings, walls are constructed using (blocks), as either load bearing or non- load bearing to provide shelter, protection, conveniently divide space, privacy and also to provide security for man and his properties [3]. This means that the importance of these blocks cannot be over emphasized, due to their importance in the construction industry. In the developing countries, like Nigeria, the construction industry is a very important sector of the economy. The rapid growth in the country's economy and population requires additional physical infrastructures to accommodate additional various component of the Gross Domestic Product (GDP). These physical infrastructures include residential and commercial buildings, agricultural and health facilities. Over 90% of physical infrastructures in Nigeria are constructed using sandcrete blocks [4]. This makes sandcrete block a very important material in building construction. Sandcrete blocks have been used for a long time throughout the country [1].

The importance of the blocks as part of the local building materials cannot be over emphasized in building and construction industry. Sandcrete blocks have been widely used for building construction in Nigeria. However, it is observed that clay suitable for making high strength bricks are not available in every place in Nigeria, and those presently used in construction are of varying grades and characteristics. The rapid changes in the use of bricks to block in Nigeria have encouraged the investigations into the use of sandcrete blocks to be more elaborate. It was also realized that some places in Ondo and Ekiti in Nigeria were occupied by rivers, which make it easier to obtain river sand rather than clay for making blocks [5]. Also in Ibadan town, sand is easily obtained from borrow pit and riverbeds situated in the environment which enhance the use of sand for making sandcrete blocks.

The characteristics strength of sandcrete blocks are influenced by a variety of factors whose effect is not sufficiently understood to permit accurate forecasting particularly under test condition. It has been found that the time of mixing sandcrete with cement does influence it characteristics strength. In the hardened state, sandcrete has a high compressive stress and this strength increases with density. Sandcrete blocks possess an intrinsic low compressive strength making them susceptible to any tragedy such as seismic activity.

Previous researches show dismal results in the production of sandcrete blocks which had exhibited compressive strength far below the standard requirement for the construction of houses but more viable option would be the use of bricks in the construction of houses. The range of minimum strength of sandcrete blocks is between 2.5N/mm^2 to 3.45N/mm^2 [1].

Odeyemi et al [2], observed that the average compressive strength of manually produced blocks and machine compacted blocks at 28th days of curing were 2.83N/mm^2 and 2.96N/mm^2 respectively. This result revealed that machine compacted blocks have a higher compressive strength than the manually compacted blocks The final compressive strength of sandcrete can be as high as 4.6N/mm^2, which is much less than concrete's 40N/mm^2. Sandcrete is unsuitable for load-bearing columns, and is mainly used for walls or for foundation if no suitable alternative is available. As material for walls, its strength is less than that of fired clay bricks, but sandcrete is considerably cheaper. Also the time lapse between mixing and compaction has been found to affect the strength. A time lag will not only diminish the hardening effect of the cement but will require extra energy to breakdown the aggregation of particles to achieve the desire density. An increase in strength with age and curing temperature has been reported for cement stabilized sandcrete, but this depends on the nature and texture of sand and the percentage of cement added. Block should be left to mature for at least 28 days (by curing them) before they are laid, if enough strength is needed [6].

2 Material and Methodology

The materials required are mostly cement and sharp sand; and equipment like; head pan, shovel, wheelbarrows, motorized vibration machine and fabricated molding box. The cement is usually stored in dry place and used within the

first two months in order to avoid the absorption of water. Sharp sand was used as fine aggregates and it was made free from deleterious substance by washing [7], posited that the most economic sandcrete blocks can be made with common sand where the red tints associated with common sand is not a detrimental factor. River sand particles are fine, but likely to vary in size and it is most suitable for plastering work. Erosion sand is similar to river but coarser than river sand. It is cheaper than river sand and has higher crushing strength because of its coarse nature [8]. Sieve analysis of the sand was done to determine its grading. This sand is used mainly for building, mortar and block molding.

Dry sieving was adopted for the sand test. Sieve analysis was carried out on a part of sand used for casting the testing samples. The sand was spread on polythene for a week to allow the natural removal of moisture. The analysis was the carried out by means of a series of sieves having convenient sizes of openings in millimeter. The series are 4.750mm, 2.360mm, 1.180mm, 0.850mm, 0.425mm, 0.300mm, 0.212mm, 0.150mm, and 0.063mm. These sieves were properly dusted and cleared with brush. The sieves were then measured including the base. The sample of the soil weighing 1000g was measured and transferred into the sieve opening 4.74mm which was on top of the serial arrangement of sieve. These sieves were put into the vibrating machine in turn for five (5) minutes. Thereafter, the amount retained on the corresponding sieves sizes was measured. The research procedure followed as sequential order as given below

- Sharp sand was obtained from a borrow pit.
- The cement and sand was measured in the ratio 1:9 by volume batching with the aid of head pans.
- The materials were then thoroughly mixed together manually until a homogenous mix with uniform color was obtained.
- Water was added in sufficient quantity to ensure workability of the mixture and the water was judged to be sufficient when a quantity of the mixture was pressed between the palms caked without bringing out water.
- In the case of the power operated method, the composite mixture (mortar) was introduced into the mold in the block molding machine and the block vibrated for a minute for adequate compaction.
- For the hand ramming method, the composite mixture was introduced in the mold; in-built with the machine, the cover of the machine was smashed against the top of the mold for several numbers of times for adequate compaction.
- Also, for the manually compacted method, the composite mixture was introduced into the mold; smashed on the ground through a height of 0.6m in order to achieve an appreciable compaction.
- The block specimen was removed from the mold and placed on the ground for curing for all the three methods highlighted above. Water was sprinkled on the blocks twice daily for proper curing for twenty (28) days.

3 Results and Discussion

The research made a comparative check on the compressive strength, density, moisture absorption capacity of sandcrete blocks using different methods of production. Tables 1-4 and Figures 1-3 show the results obtained (particle size distribution analysis, compressive strength, water absorption etc.).

Table 1: Grain size distribution of sharp sand

Sieve N0 (mm)	Weight of sieve (g)	Sieve wt + sample (g)	Weight retained (g)	% weight retained	% weight passing
4.74	460	476	16	1.6	98.4
2.36	422	478	56	7.2	92.8
1.18	377	615	238	31	69
0.85	366	476	110	42	58
0.425	324	549	225	64.5	35.5
0.3	320	445	125	77	23
0.212	310	455	145	91.5	8.5
0.15	306	357	51	96.6	3.4
0.063	295	324	29	99.5	0.5
Base	276	281	5	100	0

Table 2: Characteristics strength of 9' (225mm) blocks) using different methods of production

Age (days)	Methods of production	Compressive strength (N/mm^2)			Average Compressive strength (N/mm^2)
		1	2	3	
7	Power operated	1.48	1.5	1.56	1.51
	Hand Ramming	1.45	1.5	1.48	1.48
	Manually compacted	1.42	1.3	1.36	1.36
14	Power operated	2.02	2.03	2.05	2.03
	Hand Ramming	1.98	1.96	1.92	1.95
	Manually compacted	1.95	1.9	1.85	1.9
21	Power operated	3	3.5	3.7	3.4
	Hand Ramming	3.21	3.44	3.45	3.4
	Manually compacted	2.95	3	2.9	2.95
28	Power operated	3.95	3.92	4	3.96
	Hand Ramming	3.55	3.61	3.91	3.69
	Manually compacted	3.26	3.62	3.02	3.3

Table 3: Characteristics strength of 6' (150mm) blocks) using different methods of production

Age (days)	Methods of production	Compressive strength (N/mm^2)			Average Compressive strength (N/mm^2)
		1	2	3	
7	Power operated	1.18	1.25	1.29	1.24
	Hand Ramming	1.12	1.03	1.18	1.11
	Manually compacted	0.86	0.82	0.9	0.86
14	Power operated	1.46	1.51	1.59	1.52
	Hand Ramming	1.46	1.42	1.55	1.48
	Manually compacted	1.44	1.4	1.44	1.43
21	Power operated	1.72	1.81	1.89	1.81
	Hand Ramming	1.8	1.72	1.76	1.76
	Manually compacted	1.51	1.59	1.55	1.81
28	Power operated	2	1.94	2.13	2.02
	Hand Ramming	1.98	1.91	2.02	1.97
	Manually compacted	1.83	1.72	1.89	1.81

Table 4: Water Absorption of 9' (225mm) Sandcrete blocks using power operated, Hand Ramming and Manually Compacted Method

Method of production	Specimen	Wt of wet block (kg) M2	Wt of dry block (kg) M1	Wt of water (kg) (M2 -M1)	% water Absorption	Average absorption (%)
Power operated	1	35.32	32.12	3.2	9.96	10.34
	2	34.82	31.83	2.99	9.39	
	3	33.5	30	3.5	11.67	
Hand ramming method	1	34.6	31.8	2.8	8.81	9.93
	2	32.79	29.5	3.29	11.15	
	3	30.75	28	2.75	9.82	
Manually operated method	1	31.1	29.06	2.04	7.01	7.08
	2	31.15	29.05	2.1	7.23	
	3	31.1	29.06	2.04	7.01	

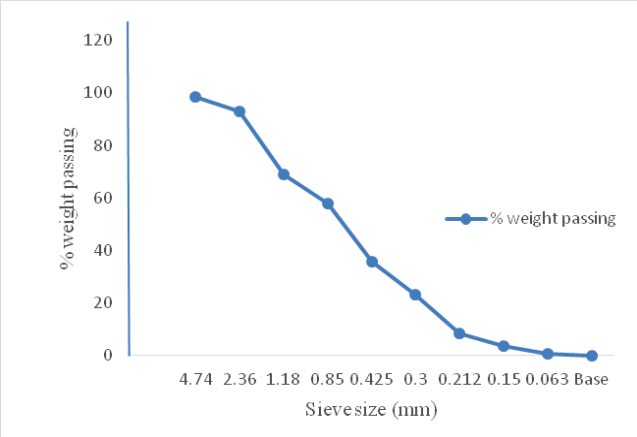

Fig 1: Particle size distribution curve of the sharp sand

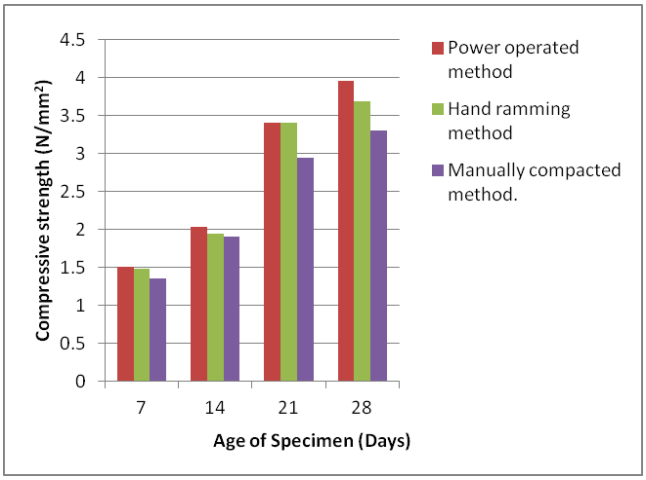

Fig 2: Bar chart showing the compressive strength of 225mm blocks using different methods

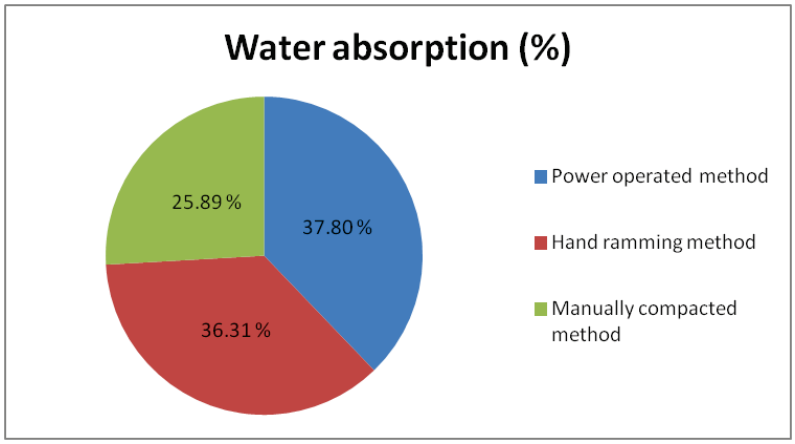

Fig 3: Pie Chart showing the Percentage of water absorption of 225mm blocks using different methods of production.

Fig 4: Manual method of producing sandcrete blocks

Fig 5: Mixing of cement-sand mortar prior hand ramming method of production

Fig 6: Hand ramming method of production

Fig 7: Block sample using hand ramming method

Fig 8: Power operated method of production

Fig 9: Curing of sandcrete blocks

Fig 9: Compressive strength of sandcrete blocks

3.1 Discussion and Analysis

The particle size distribution curve of the sharp sand with uniformity coefficient (Cu) 2.69 inferred the sand is well-graded.

The compressive strength of sandcrete blocks increased in the following order of methods of production; manual method, hand ramming method, and vibrating machine methods. At 28 days of curing, the percentage difference in strength between manual and vibrating machine is 20%

The water absorption of sandcrete blocks using vibrating machine had the highest percentage value of 37.80% amongst the three methods; with hand ramming and manual method of corresponding values of 36.31% and 25.89%.

4 Conclusion

In conclusion, the compressive strength of six (6) inches sandcrete blocks using both manually and machine operated methods at 28th days of curing were lower than that obtained by Odeyemi et al [2] and consequently that of the NIS; the mix ratio of 1:9 as against 1:6 as in the case of [2] attributed to this. The nine (9) inches sandcrete blocks produced using both vibrating machine and manual methods satisfied all the requirements as specified by the Nigerian Industrial Standards [1]. Though, the compressive strength of blocks using vibrating machine was greater than the manually produced blocks. This makes it more efficient. Also, the rate of construction of buildings cannot be overemphasized leading to high demand of sandcrete blocks and this requires an efficient and fast method of production.

The compressive strength of the sandcrete block using vibrating block molding machine is the highest of all the methods employed and this is as a result of adequate compaction obtained. Though, the compressive strength is also influenced by the cement-mortar ratio but in the course of this research, same mixed ratio was used. Also, the sandcrete blocks produced using vibrating machine absorbed more moisture than the other two method.

The highest density of 225mm and 150mm sandcrete block is greater than that of Raheem [9]. It was observed that the higher the compaction, the denser the sandcrete blocks.

It can also be concluded that the cost of production of sandcrete block using vibrating machine is reasonably more than all other methods (# 145.00 for 9'' block using vibrating machine; # 130.00 and # 120.00 for hand ramming and manual methods respectively)

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