Compressive Strength of Sandcrete Blocks in Bosso and Shiroro Areas of Minna, Nigeria

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Abstract

This paper investigates the strength characteristics of sandcrete blocks in Bosso and Shiroro areas in Minna, Nigeria. Five commercial sandcrete blocks were randomly selected and soil samples were also obtained from each manufacturer for a period of three weeks and transported to Civil Engineering Laboratory, Federal University of Technology, Minna. Compressive strength tests were conducted on the blocks and sieve analysis was also conducted on the soil samples. The test result revealed that the aggregates used are suitable for block making. The compressive strength of the sandcrete blocks is below standard recommended by Nigerian Industrial Standa (NIS) 87: 2000. The compressive strength of individual blocks was between 0.11 N/mm^2 and 0.75 N/mm^2 and the average compressive strength of the blocks were between 0.14 N/mm^2 and 0.66 N/mm^2. Proper curing and suitable selection of constituent materials was suggested to improve on the quality of sandcrete blocks.

Keywords*: Sandcrete blocks, compressive strength, aggregates, sieve analysis, grading, curing, materials.*

1. Introduction

Sandcrete blocks are composite material made up of cement, sand and water, moulded into different sizes (Barry 1969). It is widely used in Nigeria and other countries like Ghana, Irish as walling unit. The quality of blocks produced however, differs from each industry due to the different methods employed in the production and the properties of the constituent materials.

Blocks are those building unit used in the construction of wall and partitions. They are of sizes and weights that can be easily handled by the bricklayer, with the facing surface layer than that of a brick but conveniently dimensioned. Sandcrete blocks are available for the construction of load bearing and non-load bearing structures (Hodge 1971). Load bearing blocks must conform to building by law as regard to their crushing and to the amount of solid mineral contained in section e.g. the total width of block. Sandcrete blocks also participate mainly in the task of transforming the actual load from the overlaying structural element to the foundation. In this case the load bearing wall are those walls acting as supports for the whole structure to transmit the weight to the ground surface underneath it for stability (NIS 87:2000). Sandcrete blocks possess an intrinsic low compressive strength making then 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. Sandcrete blocks have been used for a long time throughout the country (NIS 87:2000). The importance of the blocks as part of 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 the clay bricks produced and presently used in construction are not uniform in quality. The rapid changes in the use of brick to block in Nigeria have encouraged the investigations into the use of sandcrete blocks to be more elaborate. It was also realised that in some places in Ondo and Ekiti States in Nigeria were occupied by rivers, which make it easier to obtain river sand rather than clay for making blocks. Also in Minna communities, sand is easily obtained from borrow pits and riverbeds situated in the environment which enhance the use of sand for block making.

The word ‘sandcrete’ has no standard definition; what most workers have done was to define it in a way to suit their own purpose. The word for it in some local dialect means brick earth and the name ‘sandcrete’ is merely a translation solely to the use to which these blocks are put. Sandcrete blocks are often too crude to reveal the nature and origin of sandcrete exhibiting the same physical properties. Though sandcrete varies within wide limit one feature remains constant; the same amount of combined silica in proportion to the alumina present, and it is in this respect that sandcrete differ from clays (Baiden and Tuuli 2004). It appears increasingly difficult to give a purely morphological, purely physical definition of sandcrete. Sandcrete covers a wide variety of aspects of tropical soil formation.

In view of the fact that no general agreement has been reached on the definition and what material should be classified as sandcrete, the trend at present is to lay emphasis on the grading i.e. sieve analysis, specific gravity test and bulk density, without much regard for mode of formation, geological and geo-morphological condition (Sparky and Lloyd 1967). The strength characteristics of sandcrete 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 its strength characteristics. 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 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 also been reported for cement stabilized sandcrete, but this depends on the nature and texture of sand and on the percentage of cement added. Vallenger (1980) observed that the compressive strength of sandcrete materials increases with increased cement content. However, it is important to understand the true significance of the foreword to BS3921: 1965 which pointed out that strength is not to be taken as an indication of durability. It has been established that the properties of a sandcrete soil that will influence its rate and ease of mixing include its degree of fineness, density, relative density and sharpness. Also the relative proportions and the number of component will considerably influence the rate of mixing (Makanjuola 1976).

Materials and Methods

For the purpose of this study commercial sandcrete block industries were visited ones each week for a period of three weeks. At each visit five sample blocks were randomly selected (NIS 87:2000). Samples of soils used for production were also collected. The blocks were weighed and tested for compressive strength using the compression testing machine in accordance to BS 2028. Sieve analysis test was carried out on the soil samples to ascertain their suitability for block making in accordance to BS 1377.

2. Results and Discussion

2.1 Sieve Analysis

The results for the sieve analysis are shown in Table 1.Sample A in the 1^{st} week satisfy the overall grading and coarse grading limit according to BS 882: 1992. Sample A in the 2^{nd} and 3^{rd} week satisfy the overall grading and medium grading limit (BS 882: 1992). However the percentage by mass finer for sieve 150µm size were in excess: 21.25% and 22.23% for 2^{nd} and 3^{rd} week. Overall grading limit requires percentage by mass finer to be between 0-15% for sieve size 150µm. This indicates an excess of fines. The soils are suitable for construction work. Sample B satisfy the overall grading limit for the three weeks period except the soil sample in the 1^{st}

week which has 19.67% finer for sieve size 150μm falling out side the limit (0-15%). Soil for sample B in the 1st week is fine grading and in the 2nd and 3rd weeks are coarse grading. Sample C satisfy the overall grading limit for the three weeks period except the percentage finer than 150μm sieve size for the 1st and 2nd weeks, which were 25.8% and 24.33% falling out side the range (0-15%). The soil is also medium grading in the 1st and 3rd week and fine grading in the 1st week. Sample D satisfy the overall grading limit for the three weeks period except the percentage finer than 150μm sieve size for the 2nd and 3rd weeks which were 20.70% and 20.26% falling out side the range. All the soils are fine grading. Sample E satisfy the overall grading limit for the three weeks period except the percentage finer than 150μm sieve size for the 2nd and 3rd weeks which were 21.78 and 17.68% falling out side the range. All the soils are medium grading. The material finer than 300μm sieve size is within the limit specified in BS 882: 1992 for all soil sample. This ensures cohesive and workable mix (Neville 2000)

2.2 Compressive Strength

The result for the compressive strength of blocks is shown in Tables 2,3,4,5 and 6.Test rest indicate that the compressive strength of individual sandcrete blocks ranges between 0.11 N/mm^2 to 0.75 N/mm^2. The average compressive strength of the five blocks ranges between 0.14 N/mm^2 to 0.66 N/mm^2. These values fall below the standard prescribed for load bearing sandcrete blocks. Nigerian Industrial Standard (NIS 87: 2000) specified that the lowest compressive strength of individual load bearing blocks shall not be less than 2.5 N/mm^2 and average compressive strength of five blocks shall not be less than 3.45 N/mm^2. The results also indicate poor quality control in the sense that the strength results show wide range within the same lot. The sieve analysis results indicate that the soil particles are suitable for construction purposes. The entire block manufacturing sites visited used potable drinking water from the tap which is recommended for construction work (BS 3148: 1980). However to obtain good quality sandcrete blocks it is essential that the constituent materials be selected with care otherwise segregation of materials and eventually low strength results. It was also noted that curing was not properly done by manufacturers of sandcrete blocks. The blocks are produced and left on the open air. The water sprinkled on them was also not adequate. Most blocks sold have not reached 28 days as a result of high demand resulting into low compressive strength.

3. Conclusion

The aggregate grading of the soils used for the manufacture of sandcrete blocks are within the limit specified by BS 882: 1992 and are therefore suitable for block making. The compressive strength of the sandcrete blocks was found to be below standard. The compressive strength of individual block tested was between 0.11N/mm^2 and 0.75 N/mm^2 while the average compressive strength of five blocks selected randomly were between 0.14 N/mm^2 and 0.66 N/mm^2 .The study suggested improvement on the selection of materials and curing.

4. References

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Table 1. Sieve Analysis of Soil Samples

Sieve size (Mm)	5.00	3.35	2.00	1.18	0.85	0.60	0.425	0.3	0.15	0.075	PAN
Sample A	Percentage Finer (%)										
1st Week	98.46	97.46	95.09	88.09	80.19	64.64	36.71	15.94	11.95	1.23	0.68
2nd Week	95.98	92.81	84.58	70.68	62.59	52.84	43.32	35.86	21.25	7.35	0.00
3rd Week	96.11	93.01	85.02	71.45	63.58	54.06	43.77	36.49	22.23	8.76	0.55
Sample B											
1st Week	99.90	99.09	95.84	86.82	78.13	64.64	49.25	36.14	19.67	11.08	0.08
2nd Week	97.91	96.25	90.83	82.47	67.48	51.62	36.44	20.71	12.83	5.52	0.03
3rd Week	97.63	90.87	75.02	61.26	53.25	42.77	29.69	20.33	11.67	2.93	0.00
Sample C											
1st Week	99.69	98.53	92.49	88.85	62.85	44.03	25.53	12.84	5.80	1.88	0.02
2nd Week	95.34	93.50	88.81	81.58	73.27	66.48	49.07	33.69	24.33	14.84	0.41
3rd Week	98.02	94.11	79.05	56.62	45.08	34.54	27.13	20.74	6.48	0.00	0.00
Sample D											
1st Week	96.55	94.88	91.94	86.29	78.98	64.17	40.08	21.63	4.40	1.72	0.02
2nd Week	98.05	95.12	87.59	78.17	67.19	56.11	42.03	31.96	20.70	11.26	8.09
3rd Week	95.88	91.29	85.61	79.51	69.89	59.89	46.59	30.18	20.26	11.33	0.00
Sample E											
1st Week	98.11	93.85	82.34	66.00	55.10	43.60	33.95	27.42	13.40	2.80	0.00
2nd Week	95.89	92.45	85.09	76.12	63.91	52.76	42.06	31.07	21.78	10.25	0.00
3rd Week	93.45	86.99	78.21	68.12	57.13	46.91	36.88	27.50	17.68	7.66	0.08

Table 2. Compressive strength of block samples A

Period Of Test	No. Of Blocks	Crushing Load (Kn)	Compressive Strength Of Block (N/Mm^2)	Mean Compressive Strength Of Block (N/Mm^2)
1st Week	1	58	0.57	0.66
	2	76	0.75	
	3	72	0.71	
	4	60	0.60	
	5	69	0.68	
2nd Week	1	70	0.69	0.54
	2	54	0.53	
	3	45	0.44	
	4	64	0.63	
	5	40	0.39	
3rd Week	1	43	0.42	0.55
	2	58	0.57	
	3	49	0.48	
	4	63	0.62	
	5	69	0.68	

Table 3. Compressive strength of block samples B

Period of test	No. of blocks	Crushing load (Kn)	Compressive strength of block (N/Mm^2)	Mean compressive strength of block (N/Mm^2)
1st Week	1	18	0.18	0.14
	2	26	0.26	
	3	10	0.10	
	4	12	0.12	
	5	11	0.11	
2nd Week	1	32	0.32	0.21
	2	14	0.14	
	3	20	0.20	
	4	28	0.28	
	5	10	0.10	
3rd Week	1	12	0.12	0.22
	2	19	0.19	
	3	25	0.25	
	4	35	0.35	
	5	21	0.21	

Table 4. Compressive strength of block samples C

Period of test	No. of blocks	Crushing load (Kn)	Compressive strength of block (N/Mm^2)	Mean compressive strength of block (N/Mm^2)
1st Week	1	38	0.38	0.24
	2	29	0.29	
	3	20	0.20	
	4	12	0.12	
	5	23	0.23	
2nd Week	1	34	0.34	0.36
	2	41	0.40	
	3	50	0.49	
	4	40	0.39	
	5	20	0.20	
3rd Week	1	25	0.25	0.30
	2	37	0.37	
	3	20	0.20	
	4	42	0.42	
	5	28	0.28	

Table 5: Compressive strength of block samples D

Period of test	No. of blocks	Crushing load (Kn)	Compressive strength of block (N/Mm^2)	Mean compressive strength of block (N/Mm^2)
1st Week	1	25	0.25	0.28
	2	47	0.46	
	3	32	0.32	
	4	15	0.15	
	5	22	0.22	
2nd Week	1	17	0.17	0.27
	2	44	0.43	
	3	18	0.18	
	4	32	0.32	
	5	24	0.24	
3rd Week	1	16	0.16	0.26
	2	32	0.32	
	3	25	0.25	
	4	20	0.20	
	5	40	0.39	

Table 6. Compressive strength of block samples E

Period of test	No. of blocks	Crushing load (Kn)	Compressive strength of block (N/Mm^2)	Mean compressive strength of block (N/Mm^2)
1st Week	1	50	0.49	0.44
	2	46	0.45	
	3	52	0.51	
	4	35	0.35	
	5	40	0.40	
2nd Week	1	52	0.51	0.43
	2	48	0.47	
	3	33	0.33	
	4	39	0.39	
	5	45	0.45	
3rd Week	1	38	0.38	0.45
	2	32	0.32	
	3	51	0.51	
	4	49	0.48	
	5	58	0.57	