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Granite Fines as a Partial Replacement for Sand in Sandcrete Block Production

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ABSTRACT

Sandcrete block, being one of the most important building materials, has become very expensive nowadays and it's on high demand in Nigeria. In order to reduce its cost and probably increase the compressive strength, this research was conducted to assess the suitability of granite fines as partial replacement for sand in sandcrete block production.
The mix proportion (1:6) was used for batching in volume. Curing was done by wetting the blocks daily. Compressive strength test was carried out on the sandcrete block for each percentage of replacement on 7, 14, 21 and 28 days. The percentage of granite fines replacement used in this research are 0%, 5%, 10%, 15%, 20%, 25% and 100%.
Result of the experiment showed that the inclusion of granite fines in the sand cement enhanced the compressive strength of sandcrete block. Sandcrete blocks made with 1:6 mix proportion using 15% granite fines replacement gave optimum compressive strength of 4.11 N/mm^2. This can be used in a structural design where higher compressive strength is required.

Keywords: *Sandcrete blocks, compressive strength, Granite fines, Structural design*

I. INTRODUCTION

Blocks made from a mixture of sand cement and water are called "sandcrete" block. They are used extensively in virtually all African countries including Nigeria. For a long time until perhaps a few years ago, these blocks were manufactured in many part of Nigeria without any reference to any specification either to suit local building requirement or for good quality work. However, the high cost of the constituent material has contributed to not being able to achieve adequate housing for both urban and rural dwellers in the country.

In order to improve the compressive strength of sandcrete blocks, granites are sometimes used as a partial replacement of the sand content in the sand-cement matrix [Falade, 1993 1999] fine granites are readily available at limestone quarries in Nigeria where limestone rocks are blasted to produce granite chippings. These chippings are now extensively used in Nigeria as coarse aggregates in the manufacturing of concrete.

Due to their porous nature sandcrete blocks generally take in fluid when exposed to moist conditions. The need to ascertain structural properties of sandcrete blocks as useful guides to their application cannot be overemphasized. Mental (1994) investigated structural effects on admixture in concrete. It was improved by Falade (1997) that the 28 days compressive and flexural strength values increased when cement was partially replaced with powdered glass in concrete manufacture. Okpala, 1993 investigated some engineering properties of sandcrete block when cement was partially replaced with Rice Husk Ash (RHA). Cisse and Laquerbe (2002) observed that the mechanical resistance of sandcrete block obtained when raw ash was added increased in performance over the classic sandcrete block. Also, since granite fines are obtained from rocks thus many properties of the aggregates depend on the properties of the parent rock (Okpala, 1999). The aggregate when used should be totally free from lumps, clay organic and vegetable matters. The presence of such impurities may result to the adhesion of the aggregates and hence reduces the strength of the concrete block. This study therefore investigate the structural properties of sandcrete blocks produced with varying proportions of sand, cement and granite fines.

The aim of the project is to replace partiallu sand with granite fines in sandcrete block production. The objective includes:

(i) To determine the optimum percentage of granite fines that could improve structural performance of sandrcrete block.
(ii) To determine the use of granite fines in the manufacture of sandcrete blocks.
(iii) To give recommendation for further study.

II. RESEARCH METHODOLOGY

The method covers material processes which involved various laboratory tests. The entire tests were carried out in the laboratory using the following apparatus/equipments. The apparatus involved are compression testing machine, weighing machine, block making machine, British standard sieve and specific density bottle. The materials were batched by volume because of different in mass of granite fine and sand. The mixes

were of 10% of the aggregate being replaced with granite fines and 90% sand. Water was added until reasonable workable mixes were obtained, and a continuous mixing was made with a spade.

The percentage of granite fines used to mould the block are 0%, 5%, 10%, 15%, 20%, 25% and 100%. The hollow blocks were cured and the compressive strength was determined at 7, 14, 21 and 28 days. The blocks were crushed on the compression machine and the strength at failure were recorded. Sandcrete blocks of mix ratio 1:6 for block size 450 mm x 225 mm x 225 mm were made for different replacement with granite fines. Table 1 shows the sieve analysis of the sand used in this experiment.

Table 1: Sieve Analysis of Sand

Sieve Size (µm)	Mass Retained (g)	Percentage Passing (%)
5000		100.00
3200	7.30	96.25
2000	20.80	85.58
1180	38.40	65.88
600	62.90	34.12
425	24.80	21.40
300	21.80	10.21
212	11.90	4.10
150	5.80	1.13
63	2.10	0.05
Pan	0.10	0.00
	Total: 194.90	

PLOT OF PERCENTAGE PASSING AGAINST PARTICLES SIZES

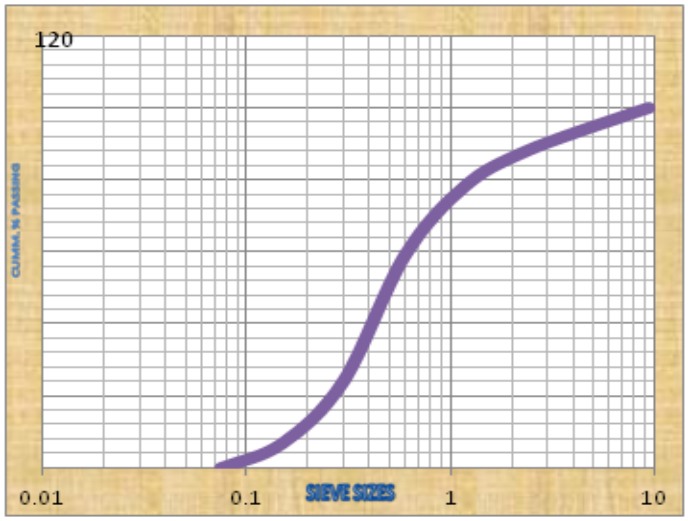

Figure 1: Plot of Percentage Passing against Particle Sizes

The results for the compressive strength tests carried out on the sandcrete blocks are shown Table 2. Figure 2 shows the Compressive Strength against the Granite fines percentages.

Table 2: Compressive Strength Result

GRANITE FINES CONTENT (%)	Compressive Strength (N/mm^2)			
	7 Days	14 Days	21 Days	28 Days
0	2.78	3.45	3.50	3.63
5	2.35	2.87	3.00	3.11
10	2.25	2.96	3.58	3.70
15	2.99	3.67	3.91	4.11
20	2.91	3.69	3.66	3.82
25	2.88	3.57	3.64	3.69
100	3.10	5.27	6.06	6.09

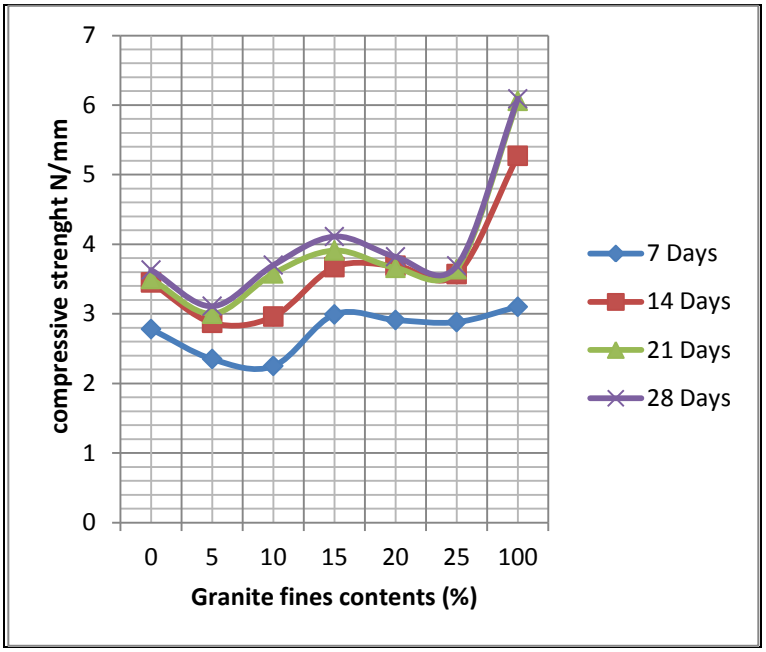

Figure 2: Compressive strength against Granite fines percentage

The weight and dry density results of the specimens are shown in Table 3

Table 3: Weight and Dry Density

GRANITE FINES CONTENT (%)	7 Days		14Days		21Days		28Days	
	Dry Weight (Kg)	Dry Density (Kg/m^3)	Dry Density (Kg)	Dry Weight (Kg/m^3)	Dry Weight (Kg)	Dry Density (Kg/m^3)	Dry Density (Kg)	Dry Weight (Kg/m^3)
0	24.33	1456.89	24.00	1437.13	24.30	1455.09	25.30	1514.97
5	24.27	1453.29	24.13	1444.91	24.03	1438.92	25.10	1502.99
10	23.46	1404.79	23.06	1380.84	23.53	1408.98	24.33	1456.89
15	23.60	1413.17	24.07	1441.32	23.97	1435.33	24.33	1456.89
20	23.70	1419.16	23.80	1425.15	24.10	1443.11	24.67	1477.25
25	23.77	1423.35	24.17	1447.31	24.43	1462.87	25.10	1502.99
100	25.27	1513.17	25.10	1502.99	25.67	1537.13	25.80	1544.91

3. DISCUSSION OF RESULT

The result shows that addition of granite fines to sandcrete blocks improves the compressive strength. Although 5% replacement showed poor compressive strength at 28 days which is approximately 14.33% less than the strength of the control specimen (0%). The good strength was shown at 100% granite fines replacement which was as a result of strong bond between cement and granite fines content. The blocks made from 1:6 mix proportion using 10%, 15%, 25% and 100% granite fine replacement meet the Nigerian Industrial Standard (NIS 2000) specification. Although, blocks from 20% of granite fines content also meet up with the specification yet the compressive strength at 14days is slightly greater than 21 days.

The graph in figure 2 shows that 15% replacement of sand with granite fines gives optimum strength of $4.11N/mm^2$ at 28 days. The blocks made from 1:6 mix proportion using 10%, 15%, 25% and 100% replacement meet the Nigerian Industrial Standard (NIS 2000) specification. The NIS specification states 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.

4. CONCLUSION AND RECOMMENDATION

Conclusions

Based on the results obtained, the following conclusions were made:

(i) Granite fines do improve the compressive strength of the sandcrete blocks.

(ii) The compressive strength increases with the age of sandcrete blocks.

(iii) The compressive strength increases from 5% to 10% granite fines replacement beyond which the strength fall.

(iv) At optimum replacement the cost for production is 0.1% higher than control specimen (0% replacement).

(v) At 15% granite fines content shows the most effective replacement for the structural performance.

Recommendations

Based on the result obtained, the following recommendations were made:

(i) Optimum compressive strength ($4.11N/mm^2$) at 15% replacement meets up with NIS specification. It should be used in structural design where high compressive strength is required.

(ii) Other mix ratio should be used to ensure broader understanding of this study.

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