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Compressive strength performance of Granite dust-Sandcrete Building Blocks

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ABSTRACT
This study encompass the empirical data of the study carried out on compressive strength determination of Granite dust-Sandcrete building blocks with granite dust as partial replacement of three(3) grades of river sand with fineness modulus(fm) of 2.29, 2.44 and 2.89. The percentage replacements ranges from 0%, 10%, 20%, 30%, 40%, 50% to 100%. A grand total of 102 sandcrete blocks of 450 × 225 × 225mm metallic mould were blend, mixed and cast with a mix ratio of 1:5. Three(3) blocks were blend, mixed and cast for each percentage partial replacement and a total 34 blocks for each grade of river sand, were crushed to obtain the compression strength of 28th day curing respectively. For river sand with fineness modulus of 2.27, the highest strength was recorded on 80% replacement, while the least strength was recorded on 0% replacement. For the same river sand, compressive strength increased from 0% to 80% and assumed a descending trend from 90% to 100%. For 2.51 fineness modulus, the highest strength was recorded on 70% replacement, while the least strength was recorded on 0% replacement. Also, for the same river sand, compressive strength increased from 0% to 70% and assumed a descending trend from 80% to 100%. For river sand of 2.91 fineness modulus, the highest strength was recorded on 80% replacement, while the least strength was recorded on 0% replacement. Also, compressive strength increased from 0% to 80% and assumed a descending trend from 90% to 100%. Generally, the compressive strength assumed an upward trend as the percentage replacement increases.

KEYWORDS*;- Sandcrete, Granite dust, Cement, sandcrete Blocks, River Sand, compressive strength.*

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I. INTRODUCTION

In this present era, the routine concrete materials such as river sand, cement and granite has become the present vogue in the construction sector. In similar trend, the construction industry has been in earnest revolution in the continuous usage of regular construction materials in civil works[9]. Amidst the economic downtrend and global economic pandemic, the conventional construction materials has been found to be increasingly exorbitant and unaffordable for low income earners[3]. Numerous researches has been channeled towards determining the best-fit materials that can partially or totally replace concrete materials such as river sand and cement and equally cut the cost of concrete productions[5]. A lot of funds and experimental efforts have been channeled towards realising this feat. This research quest lead to the development of river sand mix with various low cost materials and cement mix with various low cost materials and as well ascertaining their suitability and structural performance and standards. In similar vein, the physical properties of such low cost materials are ascertained to categorize and grade them according to structural standards[7]. Granite dust as a bye product of granite crushing has been proven to possess the required structural specifications of a concrete constituent material. Researches has shown that Granite dust can serve as fine aggregate in higher concrete grades and coarse aggregate in lightweight concrete grades. In similar trend, a lot of studies have been have carried out to ascertain the effect of these alternative materials with the structural properties such as compression strength of the concrete blend made from alternative materials. Also, the effect of the partial replacement of such materials for sand on the structural characteristics of the concrete mix[10].

Conclusively, a lot of effort have been put in place for years in bid to find an alternative to amelioratere the quantum of conventional concrete component materials[1]. This can vehemently be achieved by employing partial or total replacement of several alternative bye products which were found to pass the structural and physical standards. These alternative bye-materials must be less-cost, affordable, available and easy to source in the current economic weather[2].

This is a bid to foster their adoption and ameliorate the excessive use overuse of the material (river sand) and the incessant depletion of river bank deposits[8]. Therefore, it is suitable to utilize cheap, environmental-friendly alternative materials for cement and river sand that are preferably bye-products[6]. Granite dust has presented itself as structurally and physically suitable as a partial substitute to river sand, added

to its structural benefits and contribution to the overall sandcrete sample[4]. In recent times, Granite dust has been employed for various civil works in the construction sector such as highway pavement, production of civil work materials such as light weight aggregates, bricks and marbles.
In this study, the focal point is to determine the variational model between the compressive strength of the blocks and that of the percentage replacements.

II. MATERIALS AND METHODS

2.1 Cement

OPC cement otherwise known as Ordinary Portland Cement from the Ashaka Portland Cement Company, Ashaka, Gombe state of Nigeria with their chemical characteristics in line with british standard.

2.2 Water

A potable, colourless, odourless and tasteless potable water that was utilized for this study. It was free from debris, synthetic matter and other contaminates. The water was sourced from ground water within the catchment of Owerri city, Imo state, Nigeria.

2.3 River Sand

A river sand devoid of silt, debris, clay, grease and any chemo-organic substances. The river sands were sourced from Nwaorie river, located in Owerri municipal, Imo State, Nigeria.
The three grades of river sands utilised in this study had specific gravity of 2.48, 2.6 and 2.76 respectively; mean bulk density of 0.96g/ml, 0.97g/ml and 0.99g/ml respectively; fineness modulus of 2.29, 2.44 and 2.89; the percentage mean water absorption were 2.2%, 2.12 and 2.09% and mean moisture content of 0.95%, 0.92 and 0.93%. The coefficient of uniformity of the sand was 2.1, 2.5 and 3.01.

2.4 Granite Fines

The granite fines or dusts were gotten from a Quarry site located at Ishiagu in Ebonyi State of Nigeria. The specific gravity of the granite fines was 2.55; bulk density of 0.92g/ml ; percentage water absorption of 2.65% ; fineness modulus of 3.41 and the average moisture content was 0.51%. The coefficient of uniformity of the granite fines was 12.1.

2.4 Metallic Block Mould

The block mould utilised for casting is a metallic mould with a measuring 450×225×225mm.

2.5 Physical Analysis Of Materials:

The constituent sandcrete elements employed in this study were analysed to ascertain the following physical behaviours: sieve analysis, bulk unit weight, specific gravity, and water absorption percentage.

2.6 Granite Dust-Sandcrete Cube Production

A total of 102 sandcrete blocks samples with size of 450×225×225mm.were cast for this study using a partial replacement of granite fines of 0percent, 10%, 20%, 30 %, 40%, 50% to 100%. The mix ratio used is 1:5 and water - cement ratio of 0.4 and 0.5 respectively. The procedural steps involved in the production of the blocks samples are stated as below:
i. Determine the sundried granite dust, cement, water and river sand with the aid of mechanical weighing balance in line with the stipulated blend ratios of 1:5.
ii. Batch each component material by weight in line with the stipulated blend ratio to give about 3 block sampes for each percentage replacement.
iii. Blend all the weighed components aggregates in a container.
iv. Spray the weighed water on the blend materials using a shovel to achieve the proper homogenous mix. Then reweigh the mixed mortar.
v. Prepare the cube mould by cleaning and rubbing the internal wall surface with grease.
vi. Pour the weighed mix uniformly and in layers. Apply pressure to compact it into the metallic mould using a metallic rammer for about 20times until the mixture reaches its maximum density while in the mould.
vii. Allow the fresh sandcrete Block specimen remain in mould for 24hrs and demould it carefully, to be cured for 28days by emersing them in a curing tank.
viii. The same procedure were repeated for the other replacement of 0%, 10%, 20%, 30%, 40% to 100% respectively.

III. RESULT VIEW

The results of this study are presented on Table 1a to Table 2c and Figure 1 to Figure 3.

Table 1a and Table 1b shows Mix proportion for Granite dust-Sandcrete Block

Table 1a: Mix proportion for Granite dust-Sandcrete Block

% Replacement	0%	10 %	20 %	30 %	40 %	50 %
Blend Ratio	0.55:1:5	0.6: 1:5	0.65: 1:5	0.75: 1:5	0.85: 1:5	0.95: 1:5
Water(kg)	1.57	1.57	1.88	2.05	2.36	2.52
Cement(kg)	3.50	3.500	3.44	3.44	3.38	3.35
Aggregate(kg)	20.94	20.94	20.66	20.53	20.26	20.13
River Sand(kg)	20.94	18.85	16.53	14.37	12.16	10.07
Granite dust(kg)	0	2.10	4.13	6.16	8.10	10.07

Table 1b: Mix proportion for Granite dust-Sandcrete Building Blocking

% replacement	60 %	70 %	80 %	90%	100 %
Blend Ratio	1.05:1:5	1.1:1:5	1.15:1:5	1.2:1:5	1.25:1:5
Water(kg)	2.67	2.96	3.11	3.25	3.39
Cement(kg)	3.33	3.29	3.27	3.25	3.23
Aggregate(kg)	20.00	19.75	19.62	19.5	19.38
River Sand(kg)	8.00	5.93	3.92	1.95	0
Granite dust(kg)	12.00	13.83	15.7	17.55	19.38

Table 2a, Table 2b and Table 2c shows Compressive Strength Result of Granite dust-Sandcrete Block with river sand of fineness modulus of 2.27, 2.51 & 2.94 respectively

Table 2a: **28th day Compressive Strength Result of Granite dust-Sandcrete Blocks with river sand of 2.27 fineness modulus**

% Replacement	Average Weight(kg)	Average failure Load(N)	Area(mm^2)	Compressive Strength(N/mm^2)
0%	2.5	244000	22500	10.84
10%	2.5	246666.6	22500	10.96
20%	2.44	264000	22500	11.73
30%	2.5	280000	22500	12.44
40%	2.47	300000	22500	13.33
50%	2.49	326666	22500	14.52
60%	2.45	356000	22500	15.82
70%	2.46	342666.7	22500	15.23
80%	2.5	396000	22500	17.60
90%	2.52	362000	22500	16.09
100%	2.47	356000	22500	15.82

Table 2b: 28th day Compressive Strength Result of Granite dust-Sandcrete Blocks with river sand of 2.51 fineness modulus

% Replacement	Average Weight(kg)	Average failure Load(N)	Area(mm^2)	Compressive Strength(N/mm^2)
0%	2.64	256000	22500	11.38
10%	2.64	262000	22500	11.64
20%	2.51	276000	22500	12.27
30%	2.54	292000	22500	12.98
40%	2.6	302000	22500	13.42
50%	2.7	321333	22500	14.28
60%	2.7	337333	22500	14.99
70%	2.65	399333	22500	17.75
80%	2.5	382667	22500	17.01
90%	2.5	375000	22500	16.67
100%	2.6	361400	22500	16.06

Table 2c: 28th day Compressive Strength Result of Granite dust-Sandcrete Blocks with river sand of 2.94 fineness modulus

% Replacement	Average Weight(kg)	Average failure Load(N)	Area(mm^2)	Compressive Strength(N/mm^2)
0%	2.35	208666.7	22500	9.27407378
10%	2.25	233333.4	22500	10.3703733
20%	2.26	241333.4	22500	10.7259289
30%	2.25	278666.7	22500	12.3851849
40%	2.3	286000	22500	12.7111111
50%	2.25	296000	22500	13.1555556
60%	2.36	317333.4	22500	14.1037067
70%	2.3	334000	22500	14.8444444
80%	2.35	343333.4	22500	15.2592622
90%	2.2	326000	22500	14.4888889
100%	2.38	308000	22500	13.6888889

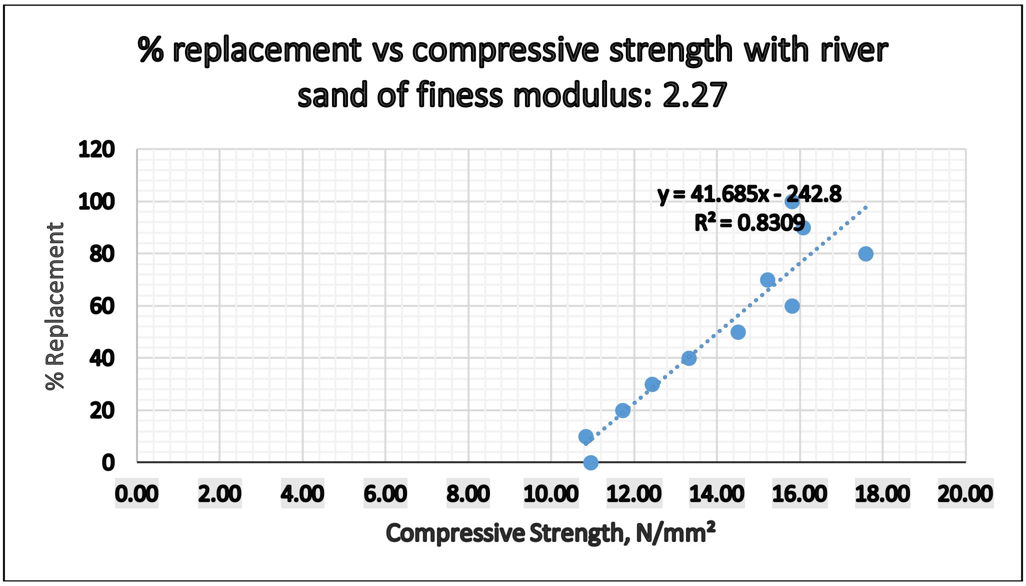

Figure 1: Linear Co-relationship between compressive strength and percentage replacement for finess modulus of 2.27

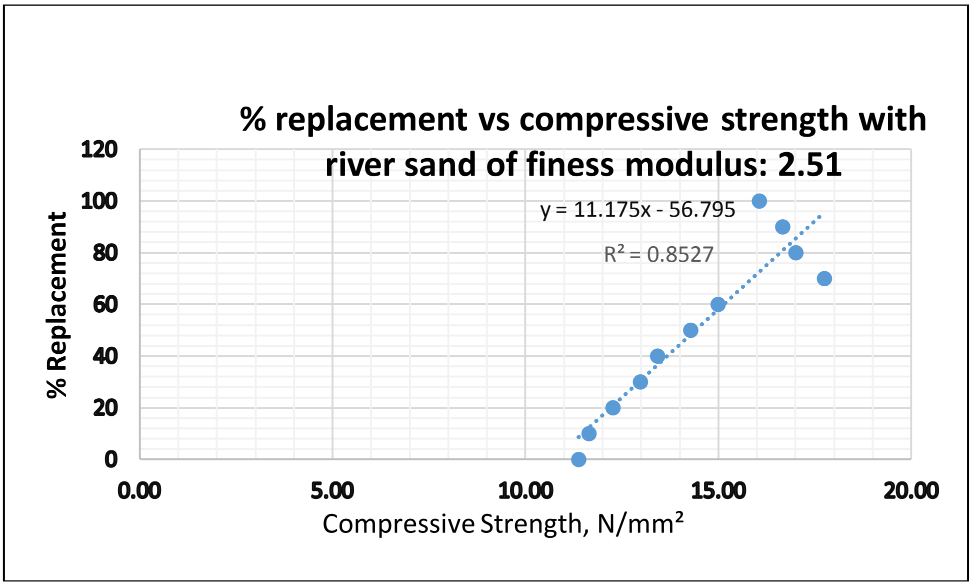

Figure 2: Linear Co-relationship between compressive strength and percentage replacement for finess modulus of 2.51

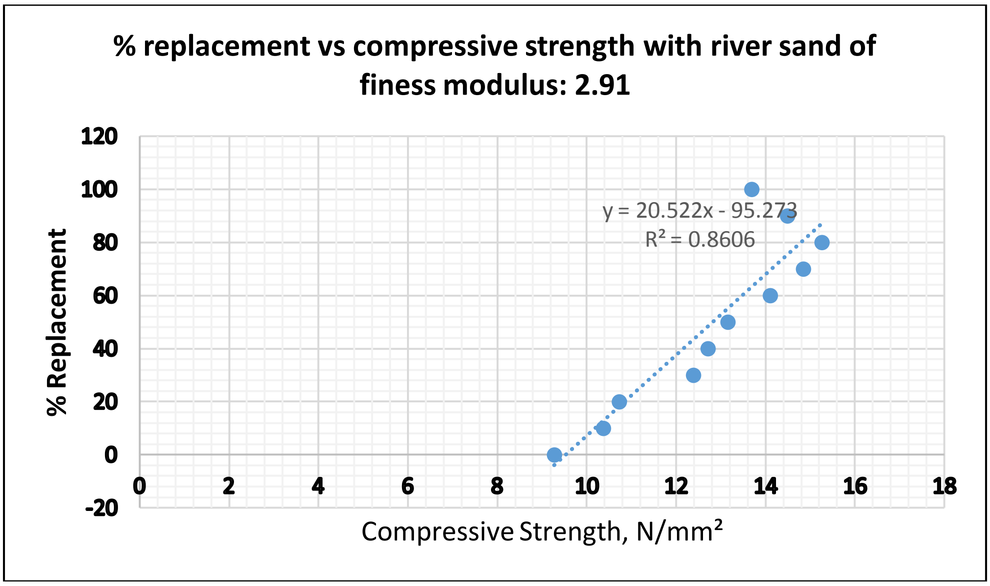

Figure 3: Linear Co-relationship between compressive strength and percentage replacement for finess modulus of 2.91

IV. DISCUSSION

Table 1a and Table 1b shows Mix proportion for Granite dust-Sandcrete Block respectively using a blend ratio of 1:5 for using river sand of 2.27, 2.51 and 2.91 fineness modulus respectively. Table 2a and shows the results of the compressive strength of Granite dust-Sandcrete Blocks with river sand of 2.27 fineness modulus. Table 2b shows the results of the compressive strength of Granite dust-Sandcrete Blocks with river sand of 2.51 fineness modulus. Table 2c shows the results of the compressive strength of Granite dust-Sandcrete Blocks with river sand of 2.89 fineness modulus.

Figure 1 shows the Linear Co-relationship between percentage replacement and compressive strength of Granite dust-Sandcrete Blocks with river sand of 2.27 fineness modulus. Also, figure 2 shows the Linear Co-relationship between percentage replacement and compressive strength of Granite dust-Sandcrete Blocks with river sand of 2.51 fineness modulus. Lastly, shows the Linear Co-relationship between percentage replacement and compressive strength of Granite dust-Sandcrete Blocks with river sand of 2.89 fineness modulus. From the linear graph, the correlation model were obtained as: $y = 41.685x - 242.8$, $y = 11.175x - 56.7$& $y = 20.522x - 95.27$ for fineness modulus of 2.27, 2.51 and 2.94 respectively. The linear coefficient were 0.83, 0.85 and 0.86 for the linear model of the percentage replacement and that of compressive strength for the 3 river sands respectively.

V. CONCLUSION

From Table 2a, the highest strength was recorded on 80% replacement, while the least strength was recorded on 0% replacement. From the same Table 2a, compressive strength increased from 0% to 80% and assumed a descending trend from 80% to 100%. From the Table 2b, the highest strength was recorded on 70% replacement, while the least strength was recorded on 0% replacement. Also, in line with Table 2b, compressive strength increased from 0% to 70% and assumed a descending trend from 80% to 100%. From the Table 2c, the highest strength was recorded on 80% replacement, while the least strength was recorded on 0% replacement. Also, in line with Table 2c, compressive strength increased from 0% to 80% and assumed a descending trend from 80% to 100%. Generally, from Figure 1, Figure 2 & Figure 3, the compressive strength assumed an upward trend as the percentage replacement increases.

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