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Original Research Article

Compressive Strength Determination of Granite Dust-Sandcrete

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Abstract

This study entails the research data of the empirical study carried out on the compressive strength determination of Granite dust-Sandcrete 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 range from 0%, 10%, 20%, 30%, 40%, 50% to 100%. A gross number of 102 cubes of 150 × 150 × 150mm square metallic mould were blend, mixed and cast with a mix ratio of 1:5. Three (3) cubes were blend, mixed and cast for each percentage partial replacement and a total 34 cubes for each grade of river sand, were crushed to derive the compression strength of 28th day curing respectively. For river sand with fineness modulus of 2.29, 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 80% to 100%. For 2.44 fineness modulus, the highest strength was recorded on 80% replacement, while the least strength was recorded on 0% replacement. Also, for the same river sand, compressive strength increased from 0% to 80% and assumed a descending trend from 80% to 100%. For river sand of 2.89 fineness modulus, the highest strength was recorded on 70% replacement, while the least strength was recorded on 0% replacement. Also, compressive strength increased from 0% to 70% and assumed a descending trend from 70% to 100%. Generally, the compressive strength assumed an upward trend as the percentage replacement increases.

Keywords: Compressive Strength, Dust-Sandcrete.

1. INTRODUCTION

In recent times, sand, cement and granite has taken the centre stage in the construction industry. In the same vein, the construction sector world has been in earnest revolution in the continual usage of conventional concrete materials in civil works of sand-quarry dust as a building material in construction industries [9]. Amidst the economic crisis and global economic pandemic, the conventional construction materials have been found to be increasingly exorbitant and unaffordable for low income earners [3].

Various studies and researches has been geared towards determining the suitable 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 channelled towards achieving this feat. This gave rise 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 same vein, the physical properties of such low cost materials are ascertained to categorise and grade them according to structural standards [7].

Granite dust as a bye product of granite crushing has been proven to meet require structural specifications a concrete constituent material. Studies 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 produced from such materials. Also, the effect of the partial replacement of such materials for sand on the structural characteristics of the concrete [10].

In conclusion, a lot of work has been done for year in bid to find an alternative to ameliorate the utility quantum of conventional concrete component materials

[1]. This is so 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 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 utilise 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 sample sandcrete[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 cube and that of the percentage replacements.

2. 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 utilised 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

River sand devoid of silt, debris, clay, grease and any chemo-organic substances. The river sands were sourced from Nwaorie River, located at in Owerri municipal, Imo State, Nigeria.

The three grades of river sands utilised in this study had specific gravity of 2.5, 2.55 and 2.72 respectively; mean bulk density of 0.92g/ml, 0.95g/ml and 0.98g/ml respectively; fineness modulus of 2.28, 2.44 and 2.89; the percentage mean water absorption were 2.17%, 2.07 and 2.04% and mean moisture content of 0.90%, 0.89% and 0.91%. The coefficient of uniformity of the sand was 2.0, 2.2 and 3.0.

2.4 Granite fines

The granite fines or dusts were gotten from the Quarry site located at Lokpanta in Okigwe Local government in Imo State of Nigeria. The specific gravity of the granite fines was 2.6; bulk density of 0.81g/ml; percentage water absorption of 2.54%; fineness modulus of 3.57 and the average moisture content was 0.44%. The coefficient of uniformity of the granite fines was 11.2.

2.4 Metallic cube mould

The cube mould utilised for casting is a metallic mould with a measuring 150×150×150mm.

2.5 Physical analyses 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 cube samples with size of 150×150×150mm 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 cube samples are stated as below:

i. Determine the sundried granite dust, cement, and 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 cubes 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 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 was repeated for the other replacement of 0%, 10%, 20%, 30%, 40% to 100% respectively.

3. RESULTS AND DISCUSSION

The results of this study are presented on Table 1a to Table 2c and Figure 1 to Figure 3. Table 1a and Table 1b show Mix proportion for Granite dust-Sandcrete mix.

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

% Replacement	0 %	10 %	20 %	30 %	40 %	50 %
Blend Ratio	0.5:1:5	0.5: 1:5	0.5: 1:5	0.55: 1:5	0.55: 1:5	0.55: 1:5
Water(kg)	0.26	0.26	0.26	0.28	0.28	0.28
Cement(kg)	0.43	0.43	0.43	0.43	0.43	0.43
Aggregate(kg)	2.1	2.1	2.1	2.08	2.08	2.08
River Sand(kg)	2.1	1.9	1.7	1.49	1.28	1.09
Granite dust(kg)	0	0.3	0.5	0.69	0.89	1.09

Table-1b: Mix proportion for Granite dust-Sandcrete mix

% replacement	60 %	70 %	80 %	90%	100 %
Blend Ratio	0.55:1:5	0.6:1:5	0.6:1:5	0.6:1:5	0.6:1:5
Water(kg)	0.28	0.3	0.3	0.3	0.3
Cement(kg)	0.43	0.43	0.43	0.43	0.43
Aggregate(kg)	2.08	2.1	2.1	2.1	2.1
River Sand(kg)	0.86	0.7	0.5	0.3	2.1
Granite dust(kg)	1.28	1.5	1.7	1.9	2.1

Table 2a, Table 2b and Table 2c shows Compressive Strength Result of Granite dust-Sandcrete mix with river sand of fineness modulus of 2.29, 2.44 & 2.89 respectively.

Table-2a: 28th day Compressive Strength Result of Granite dust-Sandcrete mix Cubes with river sand of 2.29 fineness modulus

% Replacement	Average Weight(kg)	Average failure Load(N)	Area(mm^2)	Compressive Strength(N/mm^2)
0%	2.5	122666.7	22500	5.45185156
10%	2.5	143333.3	22500	6.37036978
20%	2.5	149333.3	22500	6.63703644
30%	2.5	157333.3	22500	6.99259289
40%	2.51	161333.3	22500	7.17036978
50%	2.52	162666.7	22500	7.22962933
60%	2.49	166666.7	22500	7.40740711
70%	2.46	170666.7	22500	7.58518489
80%	2.45	174666.7	22500	7.76296267
90%	2.44	165880	22500	7.37244444
100%	2.47	163880	22500	7.28355556

Table-2b: 28th day Compressive Strength Result of Granite dust-Sandcrete mix with river sand of 2.44 fineness modulus

% Replacement	Average Weight(kg)	Average failure Load(N)	Area(mm^2)	Compressive Strength(N/mm^2)
0%	2.64	140000	22500	6.22222222
10%	2.64	162667	22500	7.22962933
20%	2.51	172667	22500	7.67407378
30%	2.54	182000	22500	8.08888889
40%	2.6	198533	22500	8.82370311
50%	2.7	218667	22500	9.71851822
60%	2.7	234800	22500	10.4355556
70%	2.65	276667	22500	12.296296
80%	2.5	317333	22500	14.103704
90%	2.5	251280	22500	11.168
100%	2.6	210667	22500	9.36296267

Table-2c: 28th day Compressive Strength Result of Granite dust-Sandcrete mix with river sand of 2.89 fineness modulus

% Replacement	Average Weight(kg)	Average failure Load(N)	Area(mm^2)	Compressive Strength(N/mm^2)
0%	2.35	116000	22500	5.15555556
10%	2.25	124000	22500	5.51111111
20%	2.26	132666.7	22500	5.896296
30%	2.25	142800	22500	6.34666667
40%	2.3	148666.7	22500	6.60740711
50%	2.25	156000	22500	6.93333333
60%	2.36	158666.7	22500	7.05185156
70%	2.35	219200	22500	9.74222222
80%	2.3	188666.7	22500	8.38518489
90%	2.2	194666.7	22500	8.65185156
100%	2.38	170666.7	22500	7.58518489

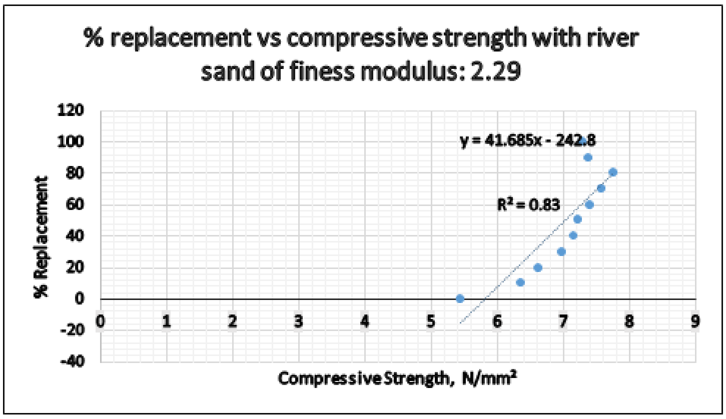

Fig-1: Mathematical Relationship between compressive strength and percentage replacement for finess modulus of 2.29

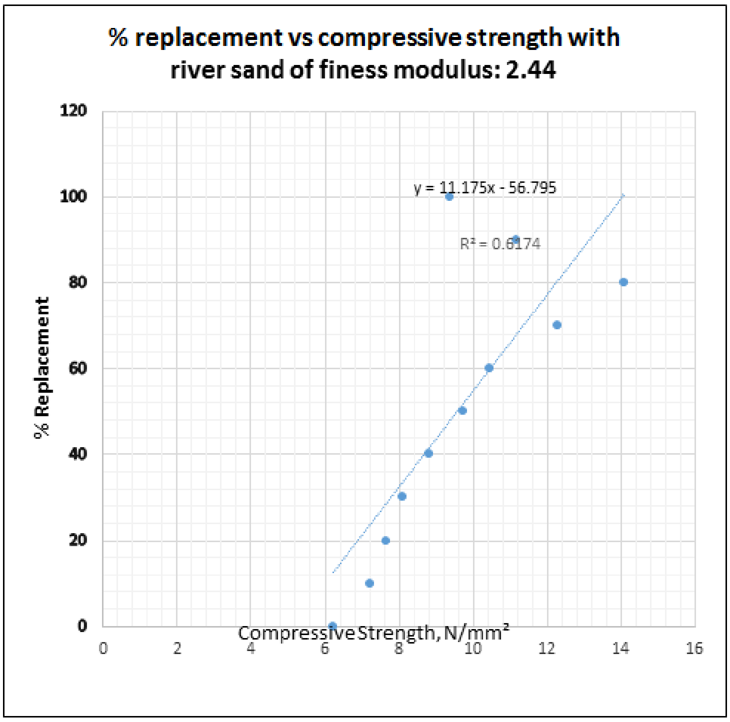

Fig-2: Mathematical Relationship between compressive strength and percentage replacement for finess modulus of 2.44

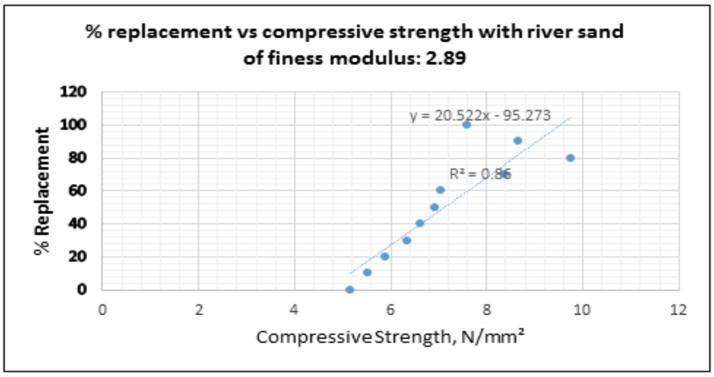

Fig-3: Mathematical Relationship between compressive strength and percentage replacement for finess modulus of 2.89

3. DISCUSSION OF RESULT

Table 1a and Table 1b shows Mix proportion for Granite dust-Sandcrete mix respectively using a blend ratio of 1:5 for using river sand of 2.29, 2.44 and 2.89 fineness modulus respectively. Table 2a and shows the results of the compressive strength of Granite dust-Sandcrete mix with river sand of 2.29 fineness modulus. Table 2b shows the results of the compressive strength of Granite dust-Sandcrete mix with river sand of 2.44 fineness modulus. Table 2c shows the results of the compressive strength of Granite dust-Sandcrete mix with river sand of 2.89 fineness modulus.

Figure 1 shows the linear mathematical relationship between percentage replacement and compressive strength of Granite dust-Sandcrete mix with river sand of 2.29 fineness modulus. Also, figure 2 shows the linear mathematical relationship between percentage replacement and compressive strength of Granite dust-Sandcrete mix with river sand of 2.44 fineness modulus. Lastly, shows the linear mathematical relationship between percentage replacement and compressive strength of Granite dust-Sandcrete mix with river sand of 2.89 fineness modulus. From the linear graph, the correlation model was obtained as: $y = 41.685x - 242.8$ $y = 11.175x - 56.795$ and $y = 20.52x - 95.27$ for fineness modulus of 2.29, 2.44 & 2.89 respectively. The linear coefficient was 0.83, 0.81 and 0.86 for the linear model of the percentage replacement and that of compressive strength for the 3 river sands respectively.

4. 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 80% replacement, while the least strength was recorded on 0% replacement. Also, in line with Table 2b, compressive strength increased from 0% to 80% and assumed a descending trend from 80% to 100%. From the Table 2c, the highest strength was recorded on 70% replacement, while the least strength was recorded on 0% replacement. Also, in line with Table 2c, compressive strength increased from 0% to 70% and assumed a descending trend from 70% 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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