PARTIAL USE OF GRANITE DUST AND IRON FILLINGS AS FINE AGGREGATE IN CONCRETE PRODUCTION

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Abstract

The high cost of construction materials has necessitated the quest for alternative materials. This project investigates the effect of using granite dust (GD) and iron filings (IF) as a partial replacement for fine aggregates [sand] in concrete production. A total number of 36 cubes concrete cubes measuring 150 X 150 X 150 mm^3, were cast, using a mix ratio of 1:2:4 and a water/cement ratio of 0.5. The specimens were tested for workability and compressive strength at 0% (control mix), (2.5% IF,10% GD), (5% IF,20% GD), (7.5% IF,30% GD), (10% IF,30% GD), replacement of sand (by weight) with iron filings(IF) and granite dust (GD) after curing in water for 28 days. The test results showed that the best gain in compressive strength was with (2.5% IF,10% GD), replacement. At this replacement level, the compressive strength increased by 16.8% compared to control. The study recommends that iron filings and granite dust can be used in concrete production as this would lead to improved environmental waste management and profitable utilization of industrial wastes.

Keywords: Iron Filings, Partial Replacement, Quarry Dust, Compressive strength, Waste

Introduction

Concrete is one of the two most used structure materials in construction (Neville A. M, 1996). Every year, the use of concrete increased by 2tonne for each person [Harrison A.W, 2003]. In order to reduce reliance of raw material in concrete producing, the green concrete had been promoted. Green concrete is the concrete that had been produced using recycle or wasted natural materials [Meyer, 2009].

Concrete is primarily composed of cement, aggregates (fine and coarse) and water. Aggregates usually make up about 75% of the volume of concrete mass. Sand is a very important component in concrete mix as it usually makes up about 30% of concrete mix. With continuous construction activities, natural reserves of these aggregates are been depleted and causing serious threats to the environment.

Availability of natural aggregates is getting depleted and costly. Hence, there has to be an emphasis on the use of waste and by-products in all areas including the construction industry. As 75% of concrete is composed of aggregates, it is imperative that we look to maximize the use of waste as aggregate input in concrete making (Kothai and Malathy, 2014).

Sand is a major material used for preparation of mortar, concrete and plaster and plays an important role in concrete mix design. Sand is required about two times the volume of cement used in concrete construction. Hence, the demand of natural sand is very high in developing countries to satisfy the rapid infrastructure growth. As demand of natural sand is increasing daily there is a need to find the new alternative material to replace the river sand, such that excess river erosion and harm to environment is prevented (Tarun et al., 2015). The growing demand of competitive market demands construction material on a large scale directed to the over utilization of river sand which has a severe detrimental effect like the raise in river bed depth, lowering of the water table and increase in saline content of river (Shrihari and Rao, 2015). Waste management is one of the most common and challenging problems in the world (Tarun et al., 2015). Prema et al. (2014) carried a research to evaluate the effect of replacing sand partially or completely in cement concrete by iron ore tailing. Malik, et.al. (2013) carried out research on the use of waste glass powder as partial replacement of fine aggregates in concrete, Kaothara et al. (2015) carried out a research work to

evaluate the structural properties of concrete with fine aggregates being substituted with granulated plastic waste (GPW) using high density polyethylene (HDPE). Kumar and Kumar (2015) in their study evaluated blast furnace slag for their suitability of replacing natural sand for making mortar and concrete. It was observed that there is an enhancement in the strength for all percentages of sand replacement. The increase in strength is, however, not very substantial. Iron filings (IF) are waste materials or by-products of iron and steel production processes. They are hazardous when disposed off to the environment. Granite dust (GD) is a byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. However, this waste material can be effectively utilized in the construction industry for concrete production. Its use in the construction industry will help to alleviate the cost of disposing the material and the imminent environmental hazard that it may cause. Efforts by researchers have been spent on the possible use of the GD and IF as fine aggregate but little or no effort has been made in the construction industry on the possibility of using the these waste combined as fine aggregate either wholly or partially in structural concrete. The aim of this study is to compare the performance of GD and IF concrete when its partially replaced in crushed rock aggregate concrete with a view to determine the suitability for concrete production while its objective is to determine the mechanical performance of GD and IF at various percentage of sand replacements.

Methodology

Materials for the Study

Dangote Portland-Limestone Cement, CEM II/B-L, Grade 42.5, (purchased in Ilaro, Nigeria), manufactured in conformity to Nigerian Industrial Standard (NIS) 444-1:2003, which is equivalent to BS EN 197-1:2000 was used for this research. Sharp river quartzite sand that is free of clay, loam, dirt and any organic or chemical matter, and maximum size of 4.75mm with a specific gravity of 2.65, water absorption of 0.9% and a fineness modulus of 2.41 was used for this research. The sand was sourced from Ilaro environs, Ogun state, Nigeria. The iron filings used for this research was sourced from workshops at Iso Part, Agodi Gate, Ibadan, Nigeria. The granite dust was obtained in Ilaro, Yewa South local government, Ogun state. Crushed granite coarse aggregates of 20mm maximum size having a specific gravity of 2.75, free from impurities such as dust, clay particles and organic matter, etc, was used. The granite was sourced in Ilaro, Ogun state, Nigeria.

Samples and Selection

For the purpose of this study a total of thirty six cubes (36) concrete cubes (150mm × 150mm × 150mm), conforming with the specifications of BS EN 12390-1:2000 was employed for this research. The replacement was done at 0% (control mix), (2.5% IF,10% GD), (5% IF,20% GD), (7.5% IF,30% GD), (10% IF,30% GD), replacement of sand (by weight) with iron filings(IF) and granite dust (GD). Three cubes cast for each percentage replacement would be used to determine the 7, 14, 21 and 28-day strength of the cubes.

Experimental Procedures

The experimental procedure began with the preliminary investigation on the basic materials to be used to determine their physio – mechanical properties. The various investigations include the following: Sieve Analysis (Particle Size Distribution), Specific gravity, Moisture content, Bulk & Dry densities. The secondary investigations carried out in the course of this research study include the following: Slump test (workability) and Compressive strength test.

Concrete Mix Design and Proportion

The materials (cement, sand and coarse aggregate) were batched by weight. The mix proportion of 1:2:4 cement-sand-coarse aggregate ratio; that is, one part by weight of cement to two parts by weight of coarse sand to four parts by weight of coarse aggregate, was employed in this investigation. A water/cement ratio of 0.5 was adopted for this research.

Findings and Discussions

Workability

Table 1: Slump Values and Degree of Workability

Percentage of iron filling (%)	Percentage of quarry dust (%)	Water/cement ratio	Slump (mm)
Nil	Nil	0.5	13
2.5	10	0.5	11.8
5	20	0.5	12
7.5	30	0.5	12.2
10	40	0.5	12.6

From the results of the above table it is found that by the introduction of iron filling and quarry dust as a partial replacement of sand there is an observed increase in slump keeping the water cement ratio, this may tend to increase the workability of the concrete.

Density of Concrete

Table 2: Average Density of Concrete Cubes in kg/m^3

Percentage of iron filling (%)	**Percentage of quarry dust (%)**	**Density of Concrete Cubes in kg/m^3**		
		7Days	**14Days**	**28Days**
0%	Nil	2435	2461	2401.5
2.5%	10	2415	2436	2439
5%	20	2452	2458	2457
7.5%	30	2434	2434	2440
10%	40	2085	2326	2330

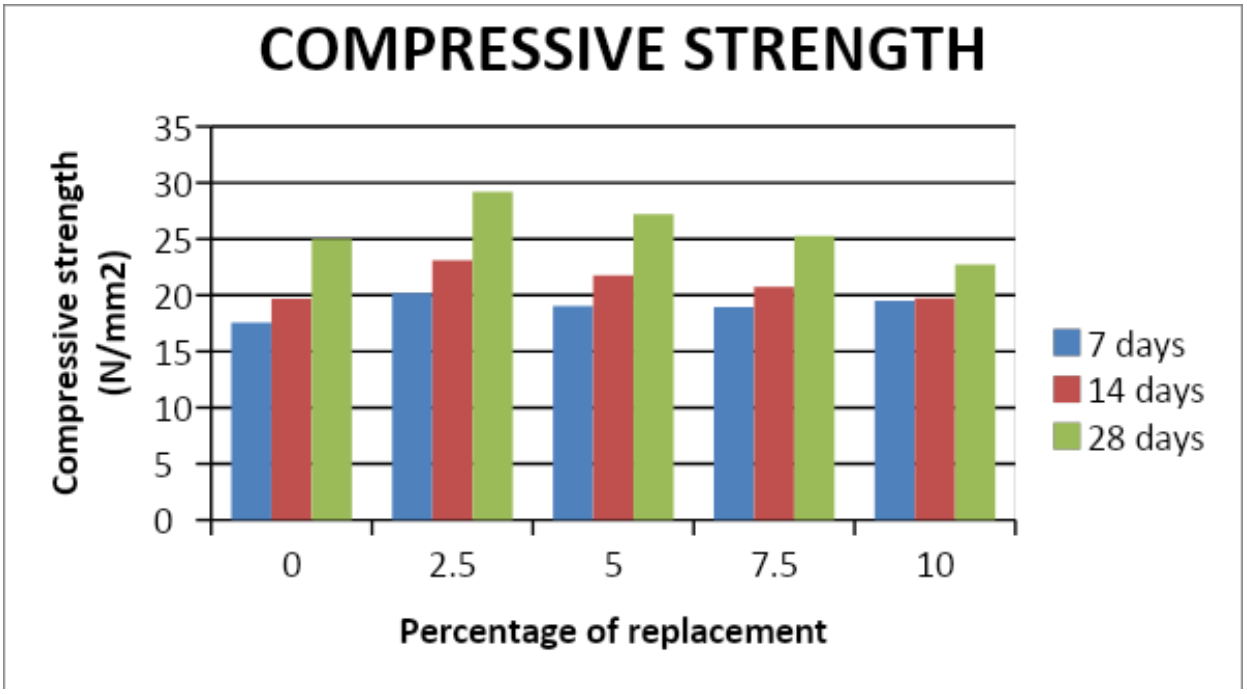
Density obtained from concrete mix sample (control) gives an average of 2401.5kg/m^3 with average of 2500 kg/m3. Concrete sample with (2.5% GD and 10% IF) have a value of 2439 kg/m^3. The concrete sample (7.5% GD and 30% IF) have a increased density value of 2440kg/m^3. It can be observed clearly that the more the quantity of material replaced the higher the density of the concrete produced. Looking at this closely, the results obtained from concrete samples of all replacement can be classified as normal concrete.

Compressive Strength Test

Table 2: Compressive Strength Test Results

Percentage of iron filling (%)	Percentage of quarry dust (%)	Water/cement ratio	Compressive Strength (N/mm2)		
			7 Days	14 Days	28 Days
Nil	Nil	0.5	17.55	19.70	25.00
2.5	10	0.5	20.20	23.08	29.20
5	20	0.5	19.05	21.75	27.25
7.5	30	0.5	18.95	20.75	25.25
10	40	0.5	19.50	19.75	22.75

From the results presented in the above table it is found that by the introduction of iron filling and quarry dust as a partial replacement of sand there is an observed increase in compressive strength of the concrete keeping the water cement ratio, however, the strength of concrete can be increased without a significant loss of workability



It is observed that increasing the iron waste and granite dust to 12.5% (2.5%, 10%) gives the highest strength among the results at 28 days, which from this point onwards increasing the amount of iron waste decreases the strength of concrete. It can be realized that using 12.5% (2.5%, 10%) of iron waste and granite dust respectively, in concrete will give 16.8% more compressive strength in 28 days than normal concrete (control).

Conclusion

i. The test results showed that the best gain in compressive strength was with 12.5% (2.5% IF, 10% GD) iron filings (IF) and granite dust (GD) replacement. The compressive strength of concrete increased for the

12.5% replacement levels of sand with iron filings and granite dust by 16.8%. However, there was an observed decrease of strength at other replacement levels.

ii. Concrete made with granite dust and Iron filings was found to have a lesser ability to resist crushing which is a fundamental reason why there is a decline in the compressive strength value at higher percentage replacement.

iii. There is a possibility for the replacement of sand (fine aggregate) with iron filings and granite in the production of concrete.

iv. The use of iron filings and granite dust in concrete production would lead to improved environmental waste management and profitable utilization of industrial wastes.

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