Global Scientific JOURNALS
GSJ: Volume 8, Issue 2, February 2020, Online: ISSN 2320-9186
www.globalscientificjournal.com

Strength of Concrete Produced from River Sands Sourced from Abuja Environs

Obafaye Babatunde Julius, Audu Mohammed Taiwo, Oseni Olumide Williams, Olukotun Adebisi
(Department of Civil Engineering/ University of Abuja, Nigeria)

Abstract: *This research work is aimed at investigating the effect of silt and clay content contained in river bed fine sand on concrete strength. It is also aimed at establishing the percentage at which silt and clay in river bed fine sands are not suitable for concrete production. Five major locations where large deposit of river bed fine sand is being used for concrete works in Abuja and environ were identified. Samples were collected from these locations namely; Bwari as sample 1, Mararaba as sample 2, Kuje as sample 3, Jere as sample 4 and Gwagwalada as sample 5. The percentage of silt and clay in each sample was determined. Thereafter, sixty (60) standard concrete cubes (150 x 150 x 150 mm) using a 1: 2: 4 mix ratio and water - cement ratio of 0.5 were cast for the samples and crushed at 7, 14, 21 and 28 days and the compressive strength determined. In order to maintain constant mixing batch in all the samples, the same coarse aggregates, cement and water mix ratio were used with these fine aggregate samples. Noticeably, the concrete produced from these fine aggregate samples did not have the same compressive strength, as samples 1, 2 and 5 with higher percentage of silt and clay content, compressive strength was below the specified value of 13.5N/mm2 for 7 days and 20N/mm2 for 28 days using mix 1:2:4.*

Key words—Tolerance limit, fine aggregate, coarse aggregate, concrete strength, compressive strength, silt and clay.

1 INTRODUCTION

According to [1], concrete is a construction material which consists of the mixture of fine aggregates, coarse aggregates and cement which is proportionally mixed with certain percentage of water. All these materials are expected to be free of debris, impurities and clay/silt particles for optimum performance. Concrete is widely used as construction composite materials for various types of structure due to its durability. For a long time, it was considered to be very durable material requiring a little or no maintenance [2]. Concrete structures can come in various shapes and sizes ranging from a simple rectangular column, to a slender curved dome or shell. [3], stated how many factors can adversely affect the strength and durability of concrete structures such as poor design, poor supervision, and impurities in aggregates. [4], explained how Civil Engineering structures have experienced various failures during their life spans due to various factors such as poor quality of sand, possibly as a result of in-adequate studies of sand properties which constitute the materials on which civil engineering structures are founded. In view of these, adequate study of sand properties from selected location cannot be overemphasized, since failure of many structures can be associated with inadequate concrete strength not meeting up the design strength. The research on the effect of clay and silt impurities in sand from different sources or locations on the strength of concrete helps in determining the suitability of sands for concrete making vis-a-vis strength and economy. Concrete strength lies on the quality of aggregates and other materials used in the production among which are cement and water [5]. Abuja is the Capital City of Nigeria located in the center of the country within the Federal Capital Territory (FCT). The Federal Capital Territory is located in the geographical center of Nigeria. It has a land area of 8000 square kilometers. It is bounded on the north by Kaduna State, the West by Niger State, the East and Southeast by Nasarawa State and the Southwest by Kogi State. It falls within latitudes 70 20′ North of the equator and longitudinal 60 45′ and 70 39′. The FCT's natural endowment such as; its rolling hills, isolated highlands and other enduring features make it a

delight. The Savannah grassland of the North and the middle belt, the richness of the tropical rain forest of the South and an equable climate all combined to make the FCT a soil-rich agricultural haven. Being the Federal Capital Territory, construction activities are continuous and proliferate. As result of this, various uses of concrete and its application for different construction work/projects are in place. For this study, five different sources/sites were selected for fine aggregate (sand) collection for concrete production. They are: Jere, Mararaba, Kuje, Bwari, and Gwagwalada. The reason for choosing these locations basically is the fact that the locations are major areas where sand used for construction purposes in Abuja are being sourced.

2 MATERIAL AND METHODS

2.1 Coarse Aggregate

The coarse aggregate employed in this study consists of granite obtained from a quarry in Abuja, Federal Capital Territory, Nigeria. It was clean, free of dirt and dust. The sieve analysis test was carried out to be 20mm size coarse aggregate.

2.2 Fine Aggregate

Fine aggregate used was five different samples from river bed sourced within Abuja and environs. The samples were dried in open space in order to attained zero moisture content. The sieve analysis of the fine aggregates was done using sieve shaker and set of sieves.

2.3 Cement

The type of cement used in this research work is the Dangote brand of Ordinary Portland Cement**.** It was sourced in Abuja, Nigeria**.**

2.4 Water

Water used in this research work for mixing and curing concrete was clean, colourless fresh water free from visible impurities and good for drinking.

2.5 Unwashed Samples for Compressive Strength Test

Fine Aggregate samples were collected from five major locations in Abuja and environs namely: Bwari, Mararaba, Kuje, Jere and, Gwagwalada/Kwali. The percentage of silt and clay content of unwashed Fine Aggregate from each of the locations were calculated. The compressive strength of the 150mm cube concrete casts was determined for each sample at 7 days, 14 days, 21 days and 28 days. The concrete cubes were crushed using Universal testing machine.

2.6 Washed Samples for Compressive Strength Test

Fine aggregate from Gwagwalada/Kwali was selected as the control sample. It thoroughly washed to achieve 0% silt and clay, and dried to achieve zero moisture content. Using a 1:2:4 mix ratio, the sample was subjected to laboratory analysis to determine compressive strength at 7days, 21days, 14days and 28days with injection of silt and clay at 0%, 2%, 4%, 6%, 8%, 10% and 12% respectively in order to determine the percentage at which silt and clay content in the sand will no longer be suitable for engineering purposes.

3 RESULT

3.1 Compressive Strength of Fine Aggregate Samples

Table 1: Shows the average compressive strength results of unwashed fine aggregate samples sourced from five major locations in Abuja and environ. The 7 days average compressive strength results at 2.99% and 5.7% silt and clay content in fine sand in samples 3 and 4 are greater than 13.5N/mm^2 and at 28 days the compressive strength results are greater than 20.00N/mm^2. This indicates that samples with 2.99% and 5.7% silt and clay content in fine sand are fit for engineering uses particularly concrete production. The 7 days average compressive strength result in samples with 9.76%, 9.68% and 15.38% silt and clay content in fine sand samples 1, 2 and 5 are less than 13.5N/mm^2 at 7 days and 20.00 N/mm^2 at 28 days. Indicating that sample 1, 2 and 5 with 9.76%, 9.68% and 15.38% silt and clay content respectively are not fit for engineering uses particularly concrete production.

Table 1: Average compressive Strength Result of Unwashed Fine Aggregate Samples 1 - 5

AGE (days)	Sample 1 (N/mm²)	Sample 2 (N/mm²)	Sample 3 (N/mm²)	Sample 4 (N/mm²)	Sample 5 (N/mm²)
7	12.61	12.49	15.94	17.03	11.28
14	15.29	15.36	18.94	19.89	14.92
21	17.40	17.75	22.14	22.33	16.18
28	19.17	18.98	23.40	24.42	17.68

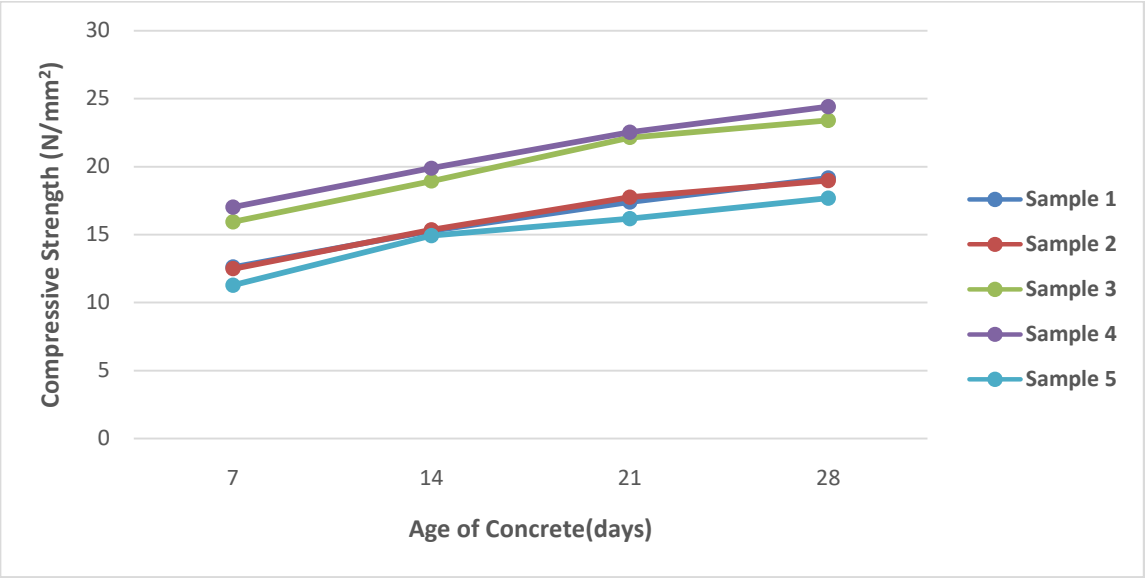

Figure 1: Average Compressive Strength Results of Unwashed Fine Aggregate Samples 1 -5

3.2 Compressive Strength of Washed Fine Aggregate

Table 2: Shows the results of Gwagwalada sample which was thoroughly washed and dried to zero moisture content and used at 2% interval partial replacement with processed silt and clay to 12%. The 7 days compressive strength result of 0% to 8% partial replacement of washed sand with processed silt and clay are greater than 13.5N/mm² and 20.00 N/mm² at 7 and 28 days (though the 28 days average compressive strength of 8% replacement is less with small margin of 19.86 N/mm² as against 20.00N/mm²), indicating that 7% silt and clay content in sand is fit for engineering uses particularly concrete production. At 10% - 12% partial replacement of washed sand with processed silt and clay, the 7 days compressive strength results is less than 13.5N/mm² and for the 28 days, the compressive strength result is equally less than 20.00 N/mm² indicating that at 8% silt and clay content and above in sand is not fit for engineering uses particularly concrete production.

Table 2: Average Compressive Strength of Washed Sand

AGE (days)	0% (N/mm²)	2% (N/mm²)	4% (N/mm²)	6% (N/mm²)	8% (N/mm²)	10% (N/mm²)	12% (N/mm²)
7	18.50	17.87	16.17	15.70	13.96	12.34	12.48
14	20.60	19.90	18.91	18.50	15.80	15.21	15.10
21	24.40	23.80	21.72	19.60	18.39	17.57	16.10
28	25.72	24.42	23.54	23.36	19.86	18.16	17.80

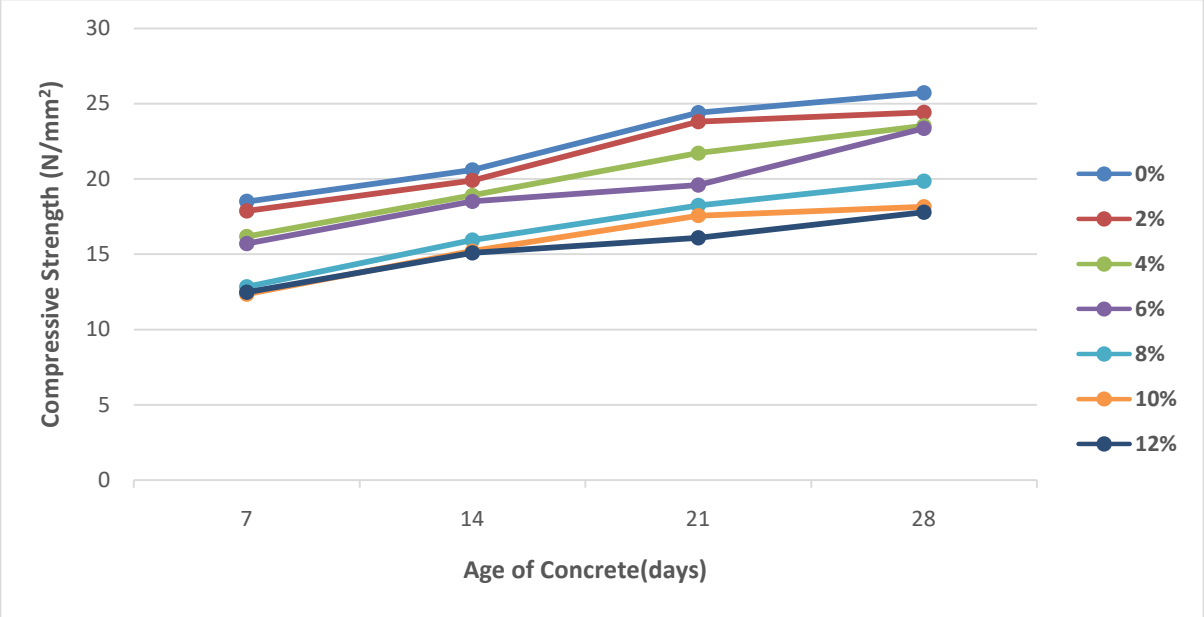

Figure 2: Average Compressive Strength of Washed Sand

Table 3: Compressive Strength Values of Concrete @ 7 & 20 days as Specified by BS 1881 which was used in this Research Work as Control Values

Grade of Concrete	Minimum Compressive Strength N/mm2 @ 7 days	Specific Characteristic Strength N/mm2 @ 28 days
M20 (1:2:4)	13.5	20

4 CONCLUSIONS

From the results of this research work, it could be concluded that:

1. The fine aggregate samples average compressive strength results both at 7 and 28 days for samples with higher silt and clay content falls below the specified standard under constant mix ratio 1:2:4 and 0.5 w/c ratio, that is sample 1, 2 and 5.
2. The percentage of silt and clay content present in all the fine aggregate samples considered falls between 2.99% to 15.38%. Sample 1 from Bwari is 9.76%, Mararaba 9.68%, Kuje 5.7%, Jere 2.99% and Gwagwalada 15.38% respectively.
3. When the load is applied on the cubes the mode of failures shows that samples with higher silt and clay content cracked completely, that is samples 1, 2 and 5.

RECOMMENDATIONS

From the findings and discussion of results in this study, the following recommendations are suggested.

1. The Jere sample river bed fine aggregate has the least silt and clay content with higher average compressive strength results at 7days and 28 days and meets engineering uses particularly concrete production follow by Kuje compressive strength results at 7 and 28 days.
2. The study showed that all fine aggregates sample sourced within Abuja and environs that have silt and clay content within the range of 9.68% to 15.38% are not advisable for concrete production based on the compressive strength results obtained at 7 days and 28 days.
3. From the partial replacement of washed sample at 2% interval, the result and analysis shows that to achieve quality concrete production, silt and clay content in a sand should not be more than 7%.

REFERENCES

[1]T.U. Ganiron "Effect of Thermoplastic as Fine Aggregate to Concrete Mixture," 2014

[2] R. Vignesh; V. Hemalatha; S. Jeyanthi Saranya, J.K. Ronnietta Kennedy, "Experimental Study on Partial Replacement of Cement by Sugarcane Bagasse Ash (SCBA)," International Journal of Engineering Research and Modern Education. Special Issue, pp. 231-243, 2017.
[3] L.M. Olanitori, "The Study on the Effect of Clay Content in the Fine Aggregate and its Impact on the Compressive Strength of Concrete," 2006
[4] L.M. Olanitori and A.O. Olotuah, "The Effect of Clayey Impurities in Sand on the Crushing Strength of Concrete" (A Case Study of Sand in Akure Metropolis, Ondo State) 2005.
[5] C.A. Ezeagu, "Optimization of the Strength of Concrete Made from Nigeria Processed Aggregate," 2007
[6] B.L. Gupta and A. Gupta, "Concrete Technology," "A.K. Johnson Publishers for Standards Publishers Distributions, Nai Sarak, Delhi, India.
[7] E.G. Nawy, "Concrete Construction Engineering Handbook," Second Edition, CRC Press, Taylor & Franciis Group, Boca Raton, 2008.
[8] S. O. Osubor, K. A. Salam and T. M. Audu, "Effect of Flaky Plastic Particle Size and Volume Used as Partial Replacement of Gravel on Compressive Strength and Density of Concrete Mix. Journal of Environmental Protection, 2019.
[9] Lafe, "Comparative Study on Strength Properties of Concrete Made with River Sand and Dane Sand as Fine Aggregate Pp 71-75, 1986.
[10] M. J. Adam, M. Rejesh, P. Brightson and M. P. Annad, "Experimental Investigation on the Effect of M-Sand in High Performance Concrete," 2013.
[11] F. O. Ayodele and I. S, Analysis of Influence of Silt/Clay Impurities Present in Fine Aggregates on the Compressive Strength of Concrete," 2015
[12] J. D. Twubahimana and B. Leopold, "Impact of Clay Particle on Concrete Compressive Strength," 2013.
[13] British Standards Institute, "BS 1881 Part 108 and 116: Compressive Strength Test of Concrete"
[14] British Standards Institute, "BS 812: Part 1: 1975 Sample, Shape, Size and Classification,'' Testing Aggregates.
[15] British Standards Institute, "BS 812-105.1: Methods for Determination of Particle Shape'' British Standard Institute, London, '' 1989.
[16] British Standards Institute, BS EN 1235 – 1, 2 & 3: Testing Hardened Concrete Shape, Determination and other Requirements for Specifications and Mould; Testing Hardened Concrete Making and Curing Specimens for Strength Tests; Testing Hardened Concrete: Compressive Strength of Test Specimens'' British Standard Institute, London,'' 2000.
[20] American Society for Testing and Materials Standards, "ASTM C470 Standard Specification for Moulds for Forming Concrete Test Cylinders Vertically, West Conshohocken, Pennsylvania, USA'' vol. 04, 1994.
[21] British Standard "(BS) 1881: Compressive Strength Test OF Concrete,''.
[22] British Standard Institute, "BS EN 206 – 1:2000: Concrete Specification Performance, Production and Conformity
[23] British Standards Institute, "BS 1881, Part 102: Methods of Determination of Slump, London,'' 1983.
[24] American Society for Testing and Materials Standards, "ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field, West Conshohocken, Pennsylvania, USA,'' Vol. 04, 2019.
[25] BS 1881: Part 116, "Method of Determination of Compressive Strength of Concrete Cubes, 1983.
[26] C. Arum and Y. A. Alhassan, "Combined Effect of Aggregate Shape, Texture and Size on Concrete Strength, Journal of Science, Engineering and Technology, 2005.
[27] S. Ahmad and S. Mahmood, "Effect of Crushed and Natural Sand on the Properties of Fresh and Hardened Concrete,'' Our World in Concrete & Structures, 2008.
[28] S. O. Nwokoye and C. A. Ezeagu, "Optimization of the Strength of Concrete Made from Nigeria Processed Aggregate, 2016.