ASSESSMENT OF THE SUITABILITY OF PIT SAND IN ILARO AND ENVIRON FOR CONCRETING WORK.

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ABSTRACT
Fine aggregate is an important constituent of concrete whose property has significant effect on the properties of both fresh and hardened concrete as well as the overall performance of concrete. For the production of sound and good quality concrete, it is important that the fine aggregate possess the required properties in accordance with relevant codes and standards. Samples of pit sand were collected from six different locations in Ilaro and environ. The samples were tested to determine the following properties: specific gravity, water absorption, moisture content, percentage silt content, bulking, fineness modulus, coefficient of uniformity and coefficient of curvature. Test result reveals that the range of values are: 2.3 – 3.27, 3.8 – 12.7%, 4.0 – 12.0%, 4.1 – 7.61%, 11-21.2%, 2.2 – 3.77, 0.8 – 5.5, 0.8 – 3.4 respectively. Comparison of the properties of the different samples with relevant codes and standards reveals that while some are in compliance with the stipulated specifications for all the properties, some failed the compliance test in some of the properties.

KEYWORDS: Assessment, Suitability, Pit - Sand, Environ, Concreting**.**

1. INTRODUCTION

Concrete is major component in the construction industry and its performance in service is a major factor in durability and serviceability of the structures in which it serves as an element. Omopariola (2018) define concrete as composite mixture consisting of mineral matter in the form of particles or aggregates which are held together by a binding material to give its solidity and strength. While Zerdi (2016) posited that concrete is the most widely used construction material today whose constituents are coarse aggregate, fine aggregate, binding material and water. He further indicated that it is a composite material produced by the homogenous mixing of selected proportions of water, cement, and aggregates. Aggregates are constituent that act as an inert material and occupies around 80 -90% by volume with fine aggregate taking about 25 – 30% of conventional Portland cement concrete. Therefore, it is a major factor in determining the overall performance of concrete due to its dominating presence

According to Ayininuola and Olalusi (2004), one of the leading causes of building collapse in Nigeria has been attributed to the use of substandard materials for concrete. Oke (2011) posited that more than 50% of cases of building collapse in Nigeria can be attributed to the use of poor quality of materials. While Balitsaris, 2012, identified improper aggregate selection and use as one of the factors responsible for failures of concrete structures. This might be the reason why Fournari and Ioannou 2019, stated that research on aggregate testing and quality control is necessary because of their in-homogeneity which does not permit the establishment of rigid specifications for their quality. This view was supported by (Ajagbe et al., 2017) in stating that provision of necessary information to local concrete industry and practitioners regarding the application of aggregates from different sources will prevent selection of substandard aggregates for concrete.

In Neville (2011), the sourcing of fine aggregates for concrete construction purposes are normally from locally available natural deposits at various locations and along the shores of rivers. This according to Neville 2011 exists abundantly as a surface deposit along the courses of rivers, on the shores of lakes and the sea, and in arid regions. Sabih, Tarefder and Jamil, (2016) asserted that sand deposits occurs in different regions of the world in varying gradation having generally irregular shapes, angular and are used primarily as fine aggregates in concrete production. It was also stated that fine aggregate comprises up to 30% of the total volume of concrete, Pit sand is used mainly for building construction as fine aggregate in the production of concrete, for block moulding and the finer pit sands are used in plastering and screeding works. In Yewa South Local Government Area of Ogun State, burrow pit sand is majorly used as fine aggregate materials for concrete production because there is only one major river source but many natural deposits of sand. The only major river (Yewa river) where sand can be abstracted is inaccessible during the raining season and the quantity of available sand is not much during the dry season. As a result of this, many building developers depend on pit sand from burrow pits for their building construction. According to Thomas & Jordan, (1987) pit sand occurs as land deposits; their grains.

2.0 LITERATURE REVIEW

2.1 Role of Aggregates in Concrete

Fournari and Iounnanou (2014) stated the essentiality of aggregates in the production of composite building structures affirming that their properties and characteristics influence their performance. The influence aggregates on the performance of concrete are stated to include provision of rigidity, strength and stiffness in the hardened state that is necessary for engineering use. According to Alexander and Mindess (2010), the fact that aggregates are the most durable and stable among the raw materials incorporated into concrete mixtures they consequently exert great influence on the durability of the hardened end-products. Mehta and Monteiro (2013) added that aggregates play a major role in determining the cost and workability of concrete. Fine aggregates have great influence on the workability and cost of concrete, while coarse sands produce harsh and unworkable concrete mixtures, very fine sands increase the water requirement and are uneconomical. The overall surface area concrete mix is increased as a result of excessive amounts of fines in aggregates with consequent increase in the amount of water required to wet all the particles in the mix, posing workability problems (Neville, 2011).

2.2 Quality of sand for building construction

Praveen et al. (2016) defined sand as a fine aggregate which is either natural sand crushed stone sand or crushed gravel sand. Different standards of sand for different construction works were further stated and the standard requirement of sand for concreting works is coarse sand with finest modulus of 2.5 to 3.5 and silt contents of not be more than 4%. Balitsaris (2012) stated that research results reveal that conformity of fine aggregate to accepted specifications is more critical than the coarse aggregate. Therefore, the use of quality sand is critical to obtaining good quality concrete. According to the Constructor, one of the conditions for construction sand to be considered to be of a good quality is that it must have a particle size measuring about 150 microns to 4.75mm.

2.3 Properties of sand

According to (Balitsaris, 2012) different aggregate from different sources inherently possess different properties. Some of the different properties of sand considered in this study are: gradation, fineness modulus (FM), coefficient of uniformity (CU), coefficient of curvature (CC), specific gravity, bulking, percentage silt content, moisture content and water absorption.

2.3.1 Gradation

One of the most important properties of aggregates is the grading or size distribution. It determines part requirement for workable concrete, dictates the proportion of aggregate to cement paste in concrete and is a major factor in the overall durability of concrete. Balistsaris (2012), Gauhar, Rafiquil and Syed (2016) identifies gradation and fineness modulus of sand as being principal factors affecting the performance of fresh and hardened concrete. Okonkwo and Arinze (2015) also stated that shaped, size and grading aggregates can influence concrete workability due to the fact that deficiencies in poorly shaped or poorly graded aggregates will necessitate increase in volume of water and cementacious materials so as to conform to the required specification. to ASTM C125-20, the gradation of sand as fine aggregate, must pass the 4.75mm (No. 4) sieve and entirely retained in the 75µm (No. 200). Sand can be classified as coarse sand in range of 4.75mm to 2mm, medium sand is in the range of 2mm to 0.42mm and fine sand in between 0.42mm 0 0.075mm. The grading limits for fine aggregates are specified by BS 882:1992 and Is 2386:1970. Mehta and Monteiro (2007) explained the effect of gradation on properties of fresh concrete by stating that when sand particles are of uniform size the spacing it has greater void spaces thus requiring more paste. On the other hand, when sand consisting of a range of sizes is used, the void spaces are filled and the paste requirement is lowered. The effect of this is that the more these voids are filled, the less workable the concrete becomes.

Four parameters obtained from sieve analysis for classifying fine aggregates. They are uniformity coefficient (Cu), the coefficient of curvature (Cc), fineness modulus and Indian Standard of classification according to zones. The uniformity coefficient (Cu) is defined as the ratio of D60 to D10. A value of Cu between 4 to 6 classifies the soil as well graded. When Cu is less than 4, it is classified as poorly graded or uniformly graded soil. Higher value of Cu indicates that the soil mass consists of soil particles with different size ranges.

Arumugam (2014), defined Fineness Modulus (FM) as an index to the particle size not to the gradation because different aggregate grading may have the same FM. It is calculated from the sieve analysis as an empirical factor relating to the fineness of the aggregate obtained by adding the total percentage of sample of the aggregate retained on each of a specified series of sieves, and dividing the sum by 100. The higher the FM the coarser the aggregate. FM of fine ranges from 2.00 to 4.00 and for coarse aggregate from 6.50 to 8.00. FM of fine aggregate is useful in estimating
proportions of fine and coarse aggregates in concrete mixtures. Fineness modulus is the most computed factor for aggregates and it is used for the determination of the degree of uniformity of aggregate grading (Concrete Portal 2017).

2.3.2 Specific Gravity

Specific Gravity of a material is defined as the ratio of Weight of Aggregate to the Weight of equal Volume of water. However IS: 383 (Part III) – 1970 defined the specific gravity of aggregates as " the weight of the aggregates dried to constant weight in an oven at 100°C divided by its absolute volume including the natural voids within the aggregate particles", while AASHTO T 84 defined it as "The ratio of the weight in air of a unit volume of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at the stated temperature". In http://www.iricen.gov.in/LAB/res/pdf/test-18.pdf, it is stated that it helps in general identification of aggregates and is considered to be a measure of strength or quality of the material. The implication of this is that aggregates with high specific gravity are presumed to be stronger than aggregates with lower specific gravity. Additionally, it provides information that helps in the determination of the volume taken up by the aggregate in different mixtures and is thus used to estimate the volume of voids in an aggregate. (Alqarni, 2013)

2.3.3 Water Absorption

Aggregates are porous materials which either shrink or swell when it releases or absorbs water respectively. These characteristics equally has significant effect on some properties of hardened concrete such as shrinkage (and therefore cracking), strength and other composite material properties. Cortas Et al. (2014). Puts the range of water absorption of aggregates at between 0.5% to 2% depending on the type of aggregate under investigation.

2.3.4 Moisture Content

The pore spaces of aggregates sometimes contain water depending on the state of the aggregates hence, the moisture content of an aggregate depends on its porosity. This property is useful in deciding upon the water/cement ratio in the course of concrete/mortar mix design Cortas (2013). Sometimes, aggregates used in concrete are usually in the dry state which makes it prone to absorb a portion of the water used during mixing. This therefore necessitates that corrections have to be made to the mix design to cater for the loss of water absorbed by the dry aggregates so as to maintain a constant water/cement ratio. It will thus help in the attainment of the desired ultimate strength of the hardened concrete

2.3.5 Bulking of Fine

Aggregates: Bulking refers to the increase in volume of a given mass of sand due to the presence of films of water that tends to push the sand particles apart. According to The Concrete portal (2017) it is more pronounced in crushed sand than natural sand and it can lead to problems during volume batching of the aggregates and causes harsh mixes with compassion problems. Consequently, Neville and brooks (2010) advocated the need to cater for this shortfall in volume by increasing the volume of fine aggregates. This can be done by multiplying the quantity of fine aggregates by the bulking factor. It is determined by measuring the decrease in volume of a given sand when inundated.

2.3.6 Percentage Silt Content

Silt refers to fine materials of aggregates which is less than 150 microns. It is unstable in the presence of water. The presence of excess quantity (> 8%) of silt in sand reduces the bonding capacity of other raw materials and affects the strength and durability of work. It is recommended that silt content test be conducted for every 20m3 of sand. The permissible Silt Content in sand according to BS 882,1982 is only 6%.

3.0 MATERIALS AND METHODS

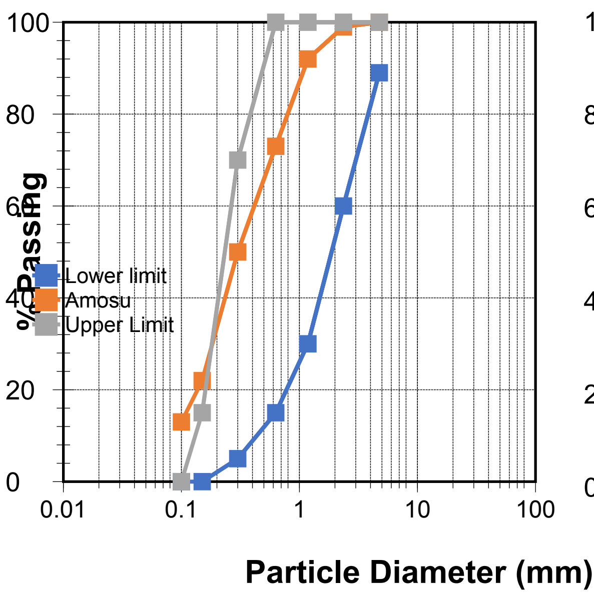
Samples were collected from six different locations in Ilaro and its environ. The six locations are: Amosu, Ebute, Egbo, Eredo, Idogo and Itolu. The samples were taken to the laboratory to test their properties in accordance with

relevant codes and standards. The various tests conducted were Sieve analysis in accordance with BS 812 – 103: 19, Moisture Content in accordance with B.S. 1377 part 2 (1990), Specific gravity and water absorption in accordance with B.S. 1881-122 (2011), bulking and percentage silt content. Values of fineness modulus coefficient of uniformity and coefficient of curvature were obtained from the sieve analysis graph.

4.0 RESULTS AND DISCUSSION

4.1 Gradation

The graphs of the sieve analysis are presented in Figures 1 – 6. From these graphs, samples of sand obtained from Ebute, Egbo, Idogo and Itolu falls within the curves of the lower and upper limit. While those from Amosu and Eredo have a little deviation from the upper limit at the points of D30 and D40 downwards respectively. The values of the percentage passing the stipulated sieve sizes indicated that the sample from Egbo can be classified as class C, those from Ebute and Itolu as Class M, while those from Amosu Eredo and Idogo are Class F according to BS 882:1992, classification for fine aggregates. Using the zoning system of IS 383:1970, Egbo sand falls into Zone II, Ebute and Itolu Zone III, Idogo Zone IV, but due to the deviation from the upper limit as stated above, samples from Amosu and Eredo could not be classified into any zone. However, BS 882: 1992 stipulated that where sand did not conform to either of the three of the thee classes, an agreed grading envelope can be used based on the suppliers assurance that the use of such materials will produce concrete of the required quality.



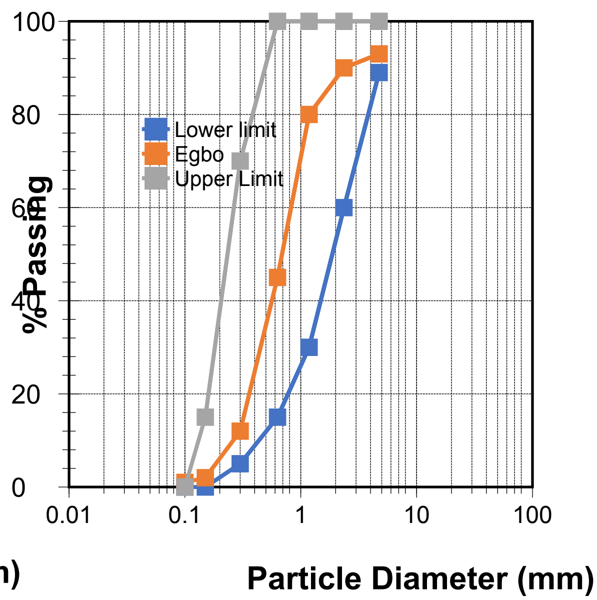
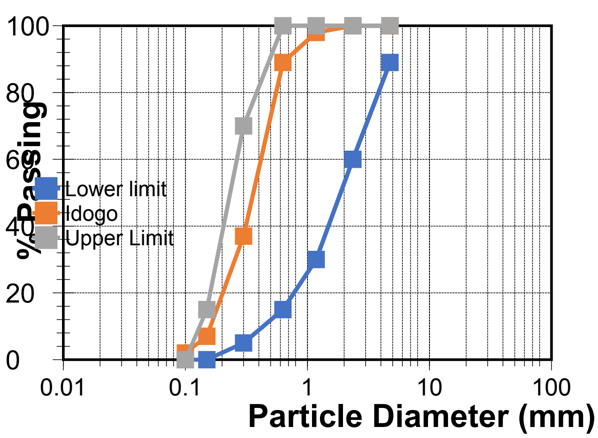


Figure 1. Sieve Analysis graph for Amosu Sand Figure 2. Sieve Analysis graph for Egbo Sand



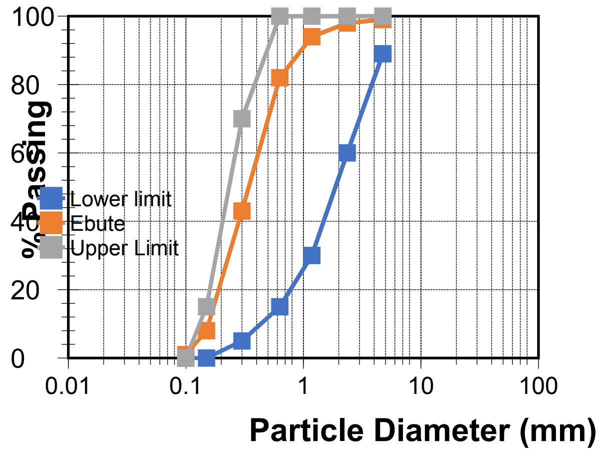
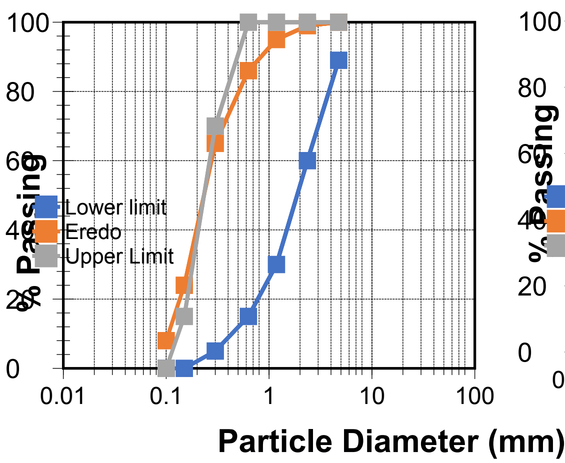


Figure 5. Sieve Analysis graph for Eredo Sand Figure 6. Sieve Analysis graph for Itolu Sand



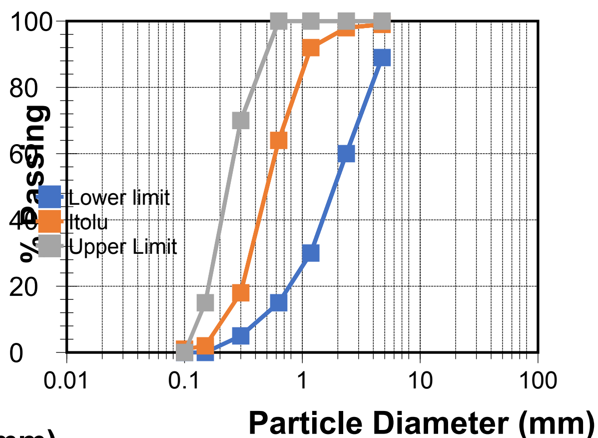
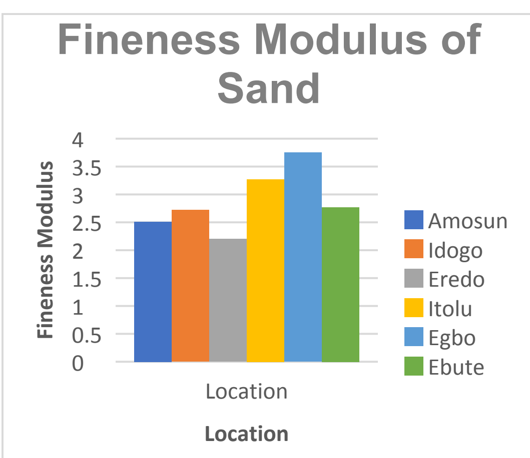


Figure 5. Sieve Analysis graph for Eredo Sand Figure 6. Sieve Analysis graph for Itolu Sand

Other parameters obtained from the sieve analysis are the Fineness Modulus, Coefficient of Uniformity and Coefficient of Curvature. From the values obtained for the Fineness Modulus, samples from all the locations fall within the range of 2.2 for Eredo sand to 3.77 for Ebute sand as can be seen in Figure 7. This is in line with the assertion of Arumugan (2014) which states that the FM of fine ranges from 2.00 to 4.00.



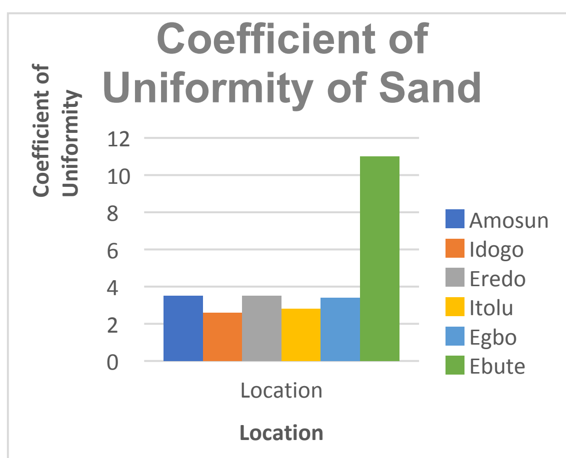
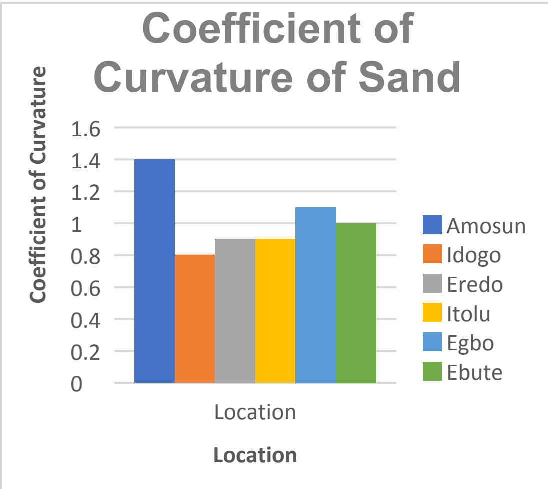


Figure 7: Bar Chart of Fineness Modulus of Sand   Figure 8: Bar Chart of Coefficient of Uniformity of Sand



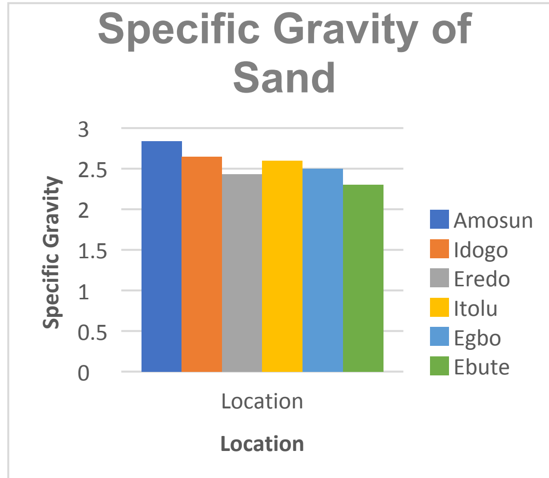


Figure 9: Bar Chart of Coefficient of Curvature of Sand   Figure 10: Bar Chart of Specific gravity of Sand

However, according to (CRD-C 104-80, 1980), this method is not widely used today in concrete mix design but it serves as a concept of being able to describe particle-size distributions by an index number. In Neville and brooks (2011), it was stated that the fineness modulus can be used to assess slight variation in aggregate grading from the same source with respect to its effect on workability of fresh concrete.

4.2 Specific Gravity

There different range of values for the specific gravity of fine aggregates in literature, the different ranges are: 2.6 – 2.7, 2.6 – 2.8, 2.5 – 3.0, and 2.4 – 2.9 (Neville, 2011, Shetty 2010, Arumugam 2014 and Nemati 2015). The values obtained from all the samples range from 2.43 – 2.84 as presented in Figure 10. This implies that the specific gravity of all the samples are in accordance with required specifications. It therefore implies that all the samples are suitable for concreting if other criteria are met.

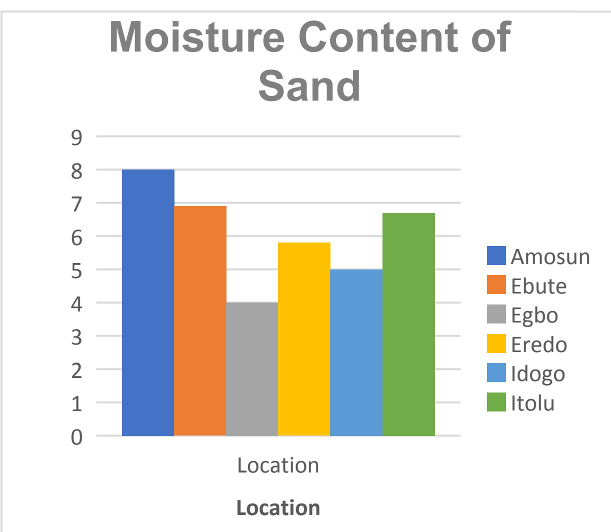


Figure 11: Bar Chart of Water Absorption of Sand   Figure 12: Bar Chart of Moisture Content of Sand

4.3 Water Absorption

The Specification for water absorption of aggregates according to BS 8007: 1987, is 3%. The values of the water absorption for all the samples as presented in Figure 11 are all higher than the specified 3%.

4.4 Moisture Content

The specified moisture content stipulated in 3%. However, results of the moisture content of samples from all locations as presented in Figure 12 are from 4 to 8 which are higher than the specified values of moisture content of less than 3% stated in relevant standards and literature. The reason for this can be as a result of the fact that the samples were collected during the raining season when the soil is naturally wet. The essence of determining the moisture content of sand is to know the amount of moisture present so that provision can be made for it when determining the water/cement ratio of the concrete mix.

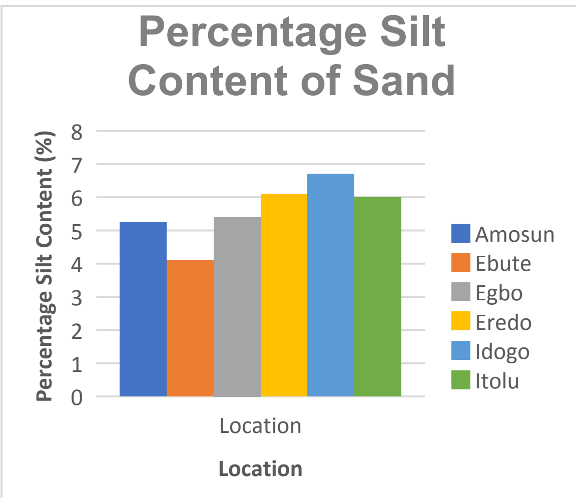


Figure 14: Bar Chart of Percentage Silt Content of Sand

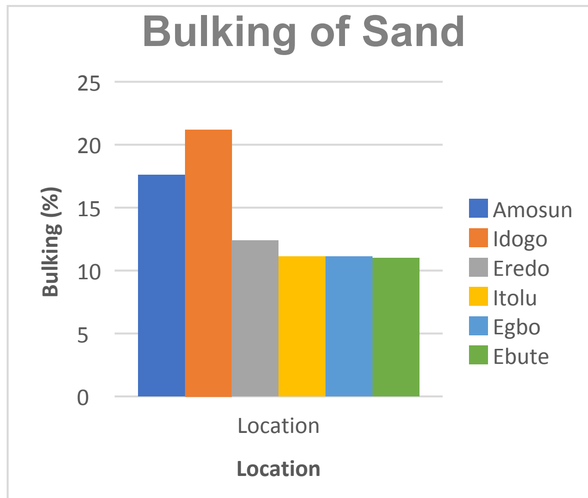


Figure 12: Bar Chart of Bulking of Sand

4.5 Percentage Silt Content

The percentage silt content of sand from all the six locations as presented in Figure 13 range from 4.1 in Ebute to 6.7 in Idogo. These values are lower than the specified value of 8% stated in BS 882:1992. These values are lesser than the 8% specified in BS 882:1992. This implies that sand obtained from all these locations are not likely to be susceptible to the effect of high percentage silt content of sand on concrete which includes reduction in the bonding between cement and aggregate, increase in water/cement ratio and an attendant reduction in concrete strength and durability. Hence, they are suitable for concreting works subject to their conformity to other criteria.

4.6 Bulking

From Figure 12, the range of values for bulking of sand from all the six locations are between 11 and 21.7. Although there is no specified limit for bulking of sand in literature, codes or standard, however, Koirala and Joshi (2017) asserted that the bulking value sand may be as high as 30 per cent of original dry volume for fine sands and 15 per cent in case of coarse sand. Going by this assertion, it implies that sand from Ebute, Egbo, Eredo and Itolu can be classified as coarse sand while that of Amosu and Idogo can be classified as fine sand. However, it must be noted that bulking of sand is not a parameter used in concrete mix design but it is very necessary when volume batching is to be used.

5.0 Conclusion

In conclusion, it can be stated that while the gradation of sands from Ebute, Egbo, Idogo annd Itolu are in line with grading limits specified in the codes, those from Amosun and Eredo had little deviations in the lower sieve sizes. By virtue of recommended specifications with regards to Coefficient of Uniformity and Coefficient of Curvature, sand obtained from Amosun Ebute and Egbo are well graded while that of Eredo, Idogo and Itolu are not well graded.the values of the specific gravity and percentage silt content for all samples conform to required standards. Summarily, all the samples are suitable for concreting work barring their deficiencies in water absorption properties.

Reference

AASHTO T 84 Specific Gravity and Absorption of Fine Aggregate

Ajagbe W. O., M. A. Tijani, Arohunfegbe I. S., Akinleye M. T., Assessment of Fine Aggregates from Different Sources in Ibadan and Environs for Concrete Production, Nigerian Journal of Technological Development, Vol. 15, No. 1,March 2018 PP8 - 13

Alexander and Mindess, 2010, Aggregates in Concrete, Modern concrete technology series

Alqarni, A.S. Quantifying the Characteristics of Fine Aggregate Using Direct and Indirect Test Methods. Master's Thesis, University of Texas, Austin, TX, USA, December 2013.

Arumugam **.**, "Effect of Specific Gravity on Aggregate Varies the Weight of Concrete Cube " SSRG International Journal of Civil Engineering (SSRG-IJCE) – volume 1 issue3 August 2014

ASTM C125 - 20 Standard Terminology Relating to Concrete and Concrete Aggregates

Ayininuola, G. M. and Olalusi, O. O. (2004). Assessment of Building Failures in Nigeria: Lagos and Ibadan Case Study. Africa Journal of Science and Technology, 5 (1): 73 – 78.

Balitsaris, Marcus, "Deviations in Standard Aggregate Gradation and its Effects on the Properties of Portland Cement Concrete"(2012).All Theses. 1502 .https://tigerprints.clemson.edu/all_theses/1502

BS 812-2:1995: Testing aggregates. Methods for determination of density, British Standard Institution London

British Standard Institute, BS 812: Part 103, (1985). "Methods for Determination of Particle Size Distribution", British Standard Institution London.

B.S. 1377 (1990): Method of Test for Soil in Civil Engineering Purpose, Part 2 British Standard Institution London

British Standard Institutes, BS 8007:1987, Code of practice for the design of concrete structures for retaining aqueous liquids, BSI British Standards

British Standard Institutes, BS 882:1992, Specification for aggregates from natural sources for Concrete

Cortas R., Rozière E., Staquet S., Hamami A., Loukili A., Delplancke-Ogletree M.-P. Effect of the water saturation of aggregates on the shrinkage induced cracking risk of concrete at early age, Cement and Concrete Composites. Volume 50, July 2014, Pages 1-9

CRD-C-104-1980, Method of Calculation of the Fineness Modulus of Aggregate.

Ede, A. N. (2011). Measures to Reduce the High Incidence of Structural Failures in Nigeria. Journal of Sustainable Development in Africa, 13 (1): 153 – 161.

Fournari, R.; Ioannou, I.; Vatyliotis, D. A Study of Fine Aggregate Properties and their Effect on the Quality of Cementitious Composite Materials. In IAEG XII Congress Engineering Geology for Society and Territory—Volume 5: Urban Geology, Sustainable Planning and Landscape Exploitation, 15–19 Sep 2014 Torino, Italy; Lollino, G., Manconi, A., Guzzetti, F., Culshaw, M., Bobrowsky, P., Luino, F., Eds.; Springer: New York, NY, USA; London, UK, 2015; pp. 33–36.

Sabih, Tarefder R.A. and Jamil S.M., 2016 Optimization of gradation and fineness modulus of naturally fine sands for improved performance as fine aggregate in concrete, International Conference on Sustainable Design, Engineering and Construction

http://www.iricen.gov.in/LAB/res/pdf/test-18.pdf,

Koirala M. P., and Joshi E B R., 2017). "Construction sand, Quality and supply management in infrastructure project", International Journal of Advances in Engineering & Scientific Research, Volume 4,(Issue 4, Jun-2017), pp 01–15.

Mehta P.K. & MonteiroP.J.M. Concrete: Structures, Properties, and Materials, 2nd Ed. Prentice Hall 2007

Mehta, P.K.; Monteiro, P.J.M. Concrete. Microstructure, Properties, and Materials, 4th ed.; The McGraw-Hill Companies: New York, NY, USA, 2013.

Nemati, K.M., Concrete Technology, Aggregates for Concrete 2015, pp 1-16,

Neville A. M. Properties of Concrete, 5th edition. Pearson Education Limited 2011

Neville A. M. & Brooks J.J. Concrete Technology, 2nd edition. Prentice Hall 2010

Oke A. 2011. An examination of the causes and effects of building collapse in Nigeria. Journal of Design and Built Environment. (9), 37–47.

Praveen S., et al ,(2015-2016), Strength Properties Of Self Compacting Concrete With Steel Fibers, Civil Engineering International Journal [CEIJ]TM Volume-1-Nov/2015-Jan / 2016 retrieved from http://civilengjournals.com/images/Journals/journals%20volume-i/Strength_Properties_Of__Self_Compacting_Concrete_With_Steel_Fibers_2015_12_16_13_27_08_558.pdf

Shetty M.S. Concrete Technology Theory and Practice S. Chand & Company Ltd. Ram Nagar, New Delhi - 110 055, 2010

Thomas,D. Jordan, J.(1987). Hand book of Gravity-flow water system (page-161-162) Unisafe

Zerdi A.T., Strength Exhibition of M25 Grade Concrete With Limestone Quarry Dust Utilization for Fine Aggregates, Global Journal of Research Analysis International Vol. 5, Issue 1, 2016 No.3, 2014 www.iiste.org