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Quality Assessment of Sandcrete Blocks Produced Along-Oke Fomo Area, Ilorin, Kwara State

[1*]Yiosese, A. O, [2]Bello, T., [3]Sulymon, N. A. and [4]Nwaigwe, D. N.

[1,2,3,4] Nigerian Building and Road Research Institute (NBRRI), Kilometer 10 Idiroko Road, Ota, Ogun State, Nigeria

[*] CorrespondingAuthor E-mail: bellotaofeeq@nbrri.gov.com Tel: 08032418798

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Abstract

In this study, the quality of sandcrete blocks produced along Oke-fomo, a rapidly developing area of Ilorin, Kwara State, Nigeria was investigated. Seven commercial block industries were randomly selected from where five sandcrete block samples of 450 x 225 x 225mm were sourced. Fine aggregate samples were also obtained from each of these industries and transported to the materials laboratory of Ministry of works, Ilorin. The tests carried out include sieve analysis and compressive strength. The dimension of the blocks was also checked. The mix ratio, curing techniques/duration and batching method were obtained through interaction with the block manufacturers. The results obtained showed that the aggregates are suitable for block making having satisfied the overall grading requirement specified in BS EN 12620 (2002). The mix ratio adopted by the industries ranges from 1:12 to 1:14 which is against the standard 1:6 specified in NIS 87:2004. The compressive strength of the sandcrete blocks was found to be below the Nigerian Industrial Standard (NIS) 87:2004 specification with an overall highest compressive strength of 0.98N/mm^2 when compared with the NIS 2.5 and 3.5N/mm^2 for non-load and load bearing walls respectively. The study concluded that block producer should adhere strictly to the laid down standard especially in mix ratio and curing duration. However, it was recommended that formal training should be periodically organized for block industries and the public should also be sensitized about the danger in using substandard sandcrete blocks. This will to a large extent improve the production of quality sandcrete blocks and promote the market for the standardized ones while averting consequences associated with weak sandcrete blocks such as collapse of walls.

Keywords: Sandcrete block, Mix-ratio, Aggregates, Particle size distribution, Compressive strength.

Introduction

Sandcrete block is a major component of a building structure. It is widely used in Nigeria and many other parts of the world as non-structural and structural building elements. According to the Nigerian industrial standard, a sandcrete block is a composite material made up of cement, sand and water moulded into different sizes. Sandcrete block can be used as external and internal walls. It can also be used as load bearing or non-load bearing walls. Sandcrete blocks account for over 60% of materials in most buildings (Ewa and Ukpala, 2013). Onwuka, Osadebe and Okere (2013) reported that the percentage of walling materials made of sandcrete blocks account for over 95% of all materials. Sandcrete block are widely used in Nigeria as walling units and over 90% of houses in Nigeria are being constructed of sandcrete blocks. This makes sandcrete blocks a very important material in building construction (Alejo, 2020). Sandcrete blocks have manufactured both manually and mechanically to meet the need of building construction. This was done without putting into consideration the strength and durability of blocks (Anosike and Oyebade, 2011).

In Nigeria, failure of structures is growing at an alarming rate and urgent measures are needed to curb this unwanted occurrence. To achieve this, the contribution of sandcrete blocks being one of the major building materials cannot be over looked. Omoregie and Alutu (2006) reported that poor quality control and the use of substandard building materials are the major factors responsible for building collapse in Nigeria. It is therefore not surprising when a building collapse even at the construction stage when sandcrete block can even fail during transportation to site.

Some of the factors affecting the strength of sandcrete blocks are the curing, optimum water content and quality control (Odeyemi *et al*, 2018). Curing is key in the strength development of cement application materials. Poor curing has been found to lower the strength of the cement application materials. Other factors that influence the strength of cement application materials are cement, aggregate gradation and mix-ratio (Odeyemi *et al*, 2019; Mohammed and Anwar, 2014). Many block making industries in Nigeria however do not give regards to these factors probably due to lack of the basic knowledge or in their selfish bid to maximize profit.

The problem of quality control is further aggravated by lack of constant checks and balances by the concerned authorities in the system. There are no articulated programs to check the activities of these block manufacturers even though there are laid down specifications by the Nigerian Industrial Standard (NIS), there is little or even no compliance to the regulations in most cases (Mohammed and Anwar, 2014). Oyekan and Kamiyo (2011) reported that most sandcrete blocks in Nigeria are manufactured without any reference to suit local building requirement or good quality work. Even within the stocks of manufacturers, one can find sandcrete blocks of varying qualities indicating a poor-quality control practice. In Nigeria, establishing or setting up sandcrete block industries require no formal or strict registration as one can find lots of these local block industries scattered all over the country. Most of these industries do not follow standards and they continually churned out blocks of low quality thereby bringing harm to the general society (Anthony *et al*., 2015).

This research therefore looked into the strength quality of sandcrete blocks produced along Oke-fomo area, Ilorin by evaluating the physical properties of the fine aggregate, mix ratio, dimensions and the compressive strength of the blocks before sale with a view to compare these properties with the standards laid down by the Nigeria industrial standard. Interest was in this area because it is a newly developing area and the rate at which block industries are being sited around this location is alarming and calls for attention.

Materials and Methods

The materials used basically in this study were sandcrete block and Fine aggregate (sand) and were sourced from seven commercial sandcrete block producers along Oke-fomo area in Ilorin. The block industries were visited and 5 samples of 450 x 225 x 225mm blocks ready to be sold were randomly selected. Samples of fine aggregate (sand) used for the production of the blocks were also collected from each industry. It was generally observed that Dangote type 3X cement is commonly used around the sampling area. Personal interaction with the manager at the block industries and careful observation was made to note the following information: materials used in producing the blocks, mix ratios adopted, batching method used, method of mixing, method of production/moulding, curing method and duration and number of blocks produced per bag of cement. Laboratory test such as sieve analysis was conducted on the collected fine aggregates, while the sandcrete blocks were tested for their compressive strengths. The geometry of the block samples was also noted for comparison with the recommendations of (NIS 87, 2004).

Compressive Strength Test: This test was done in order to determine the load carrying ability of the blocks. The blocks were weighed and tested in accordance to BS EN 12620 (2002) using the compressive testing machine. The loads at failure of the blocks were recorded and the compressive strength was determined from the relation:

$$CompressiveStrength(N/mm^2) = \frac{Maximum\ load\ at\ failure\ (N)}{Effective\ Crosssectional\ Area\ (mm^2)} \qquad (1)$$

Sieve Analysis: Sieve analysis was carried out in accordance with BS-882 on the aggregate samples in order to classify and determine their properties.

Results and Discussion

Materials used for sandcrete block production

All the block industries visited were observed to have a common practice of combining two different types of fine aggregates for their block production (sharp and soft that appears plastic by visual examination in contact with water). Their explanation on the addition of soft sand was generally that the material provides more binding effect as well as increasing the volume of the mix thereby increasing their profit without giving the strength of block any consideration. Their sharp and soft sand combination is presented in Table 1 where it can be observed that the combining rate can be as high as 50/50% especially in industry C, E and G. However, others had higher sharp sand content than soft sand.

Batching/Mix Ratio: The batching method in use across all the industries was the volume method where wheel barrow was being used to heap the sand to a certain level based on the discretion of the operator. This implies that there is no definite quantity in volume at every measurement. In addition, there is no particular operator as the manager may decide to hire a different operator at any point in time. Therefore, there cannot be consistency in the batching operation as this largely depends on the decision of the operator. The common mix ratio observed as presented in Table 1 are 1:12 and 1:14 as against 1:6 recommended by (NIS 87: 2004) for load bearing blocks.

Mixing, Production and Curing: The mixing method observed for production in all the seven industries visited was predominantly hand/manual mix with the use of shovel. This method cannot be effective in achieving homogeneous mix particularly for large volume production. Compaction of the blocks was mechanical as observed across all the industries visited. Mechanical method includes vibration which remove void and allows for adequate compaction. However, a good strength cannot be achieved with only proper vibration; every operation involved in the production line must be adequately monitored and executed. Curing on the other was generally done by surface wetting as shown in Table 1. A minimum of 3 days as against the specified 7 days was used for curing before selling/supplying to customers. Literatures reported that cement application materials attain most of their strength (about 70%) at 7 days (Sravan *et al*, 2016). This means that the blocks have not been allowed to adequately cure and this could bring about low strength block. As presented in Table 1, the number of 225 x 225mm blocks produced per bag of cement ranged from 40-49 across all the industries against the preferred range of 25-30 (Oladeji and Awos, 2013). This is expected to inhibit the strength quality of the blocks because the cement content in the mix would have reduced as a result of excess addition of fine aggregates.

Table 1: Mixing, curing and number of block produced per bag

Industry	Mix Ratio	Curing Method	Curing Duration (Days)	Number Produced Per Bag of Cement	Content of Sharp sand (%)	Content of added soft sand (%)
A	1:14	Wetting	3	45	57.1	42.9
B	1:12	Wetting	3	40	66.7	33.3
C	1:14	Wetting	3	40	50.0	50.0
D	1:12	Wetting	3	40	58.3	41.7
E	1:12	Wetting	3	45	50.0	50.0
F	1:12	Wetting	3	49	66.7	33.3
G	1:12	Wetting	3	40	50.0	50.0

Geometrical checks on blocks: The checks revealed that there were variations in the dimensions of the blocks from various industries. Table 2 showed the geometry of all the blocks collected from the various industries where it can be seen that none of the producers conformed to the geometrical specification of 450x225x225 mm sandcrete block. All the producers exceeded the 450mm length specified by the *(*NIS) 87:2004 while four industries (A, B, C and G) are in conformity with the breadth of between 225/230mm specified, only one industry (F) is in line with the height specification and two conformed to the web specification of NIS. Generally, none of the industries completely comply with the geometrical specification of 450x225x225 mm hollow sandcrete block in line with (NIS 87: 2004).

Table 2: Geometrical properties of block from different industries and the NIS values

Block Industry	Average Length (mm)	Average Breadth (mm)	Average height (mm)	Average Web (mm)
A	460	230	213	48
B	460	230	216	40
C	460	230	225	50
D	460	232	226	52
E	460	232	226	49
F	460	235	230	50
G	460	230	226	60
NIS	450	225	225	50

Particle size distribution: The results of sieve analysis are shown on the particle size distribution curves in Figure1 - 7. The result shows that all the aggregates sample satisfy the overall grading limit according to BS EN 12620 (2002) and are therefore suitable for block making purpose. Aggregate sample from block industry A, B, C, E, and G are of medium grading, sample from block industry D and F are fine grading this is evident as their grading curve can be seen to fall toward the left (lower bound).

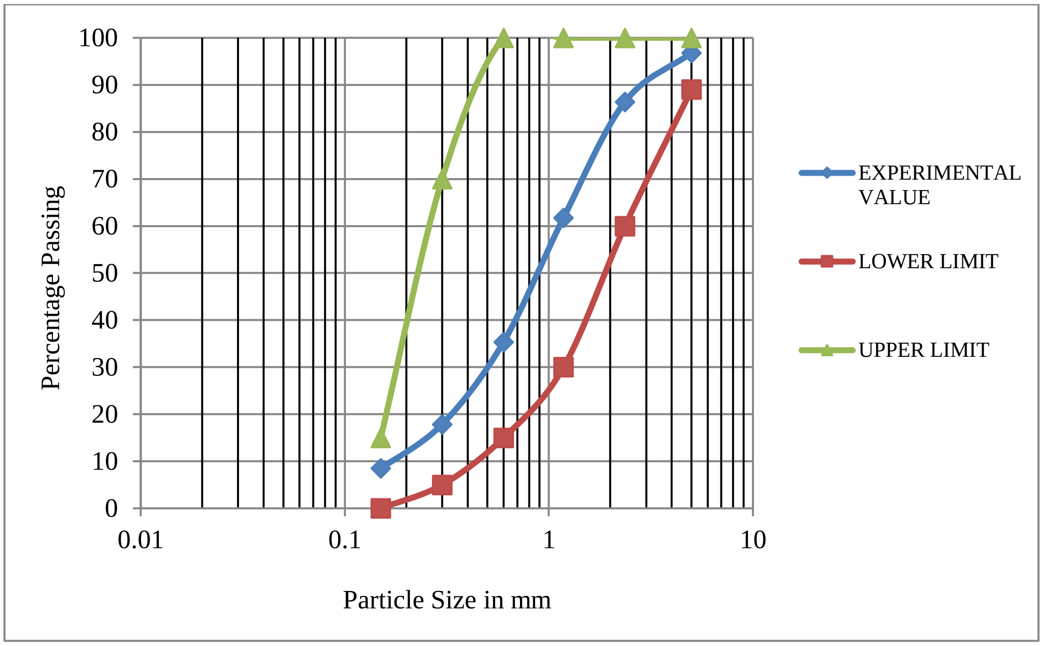

Figure 1: Particle Size Distribution Curve of aggregate for industry A

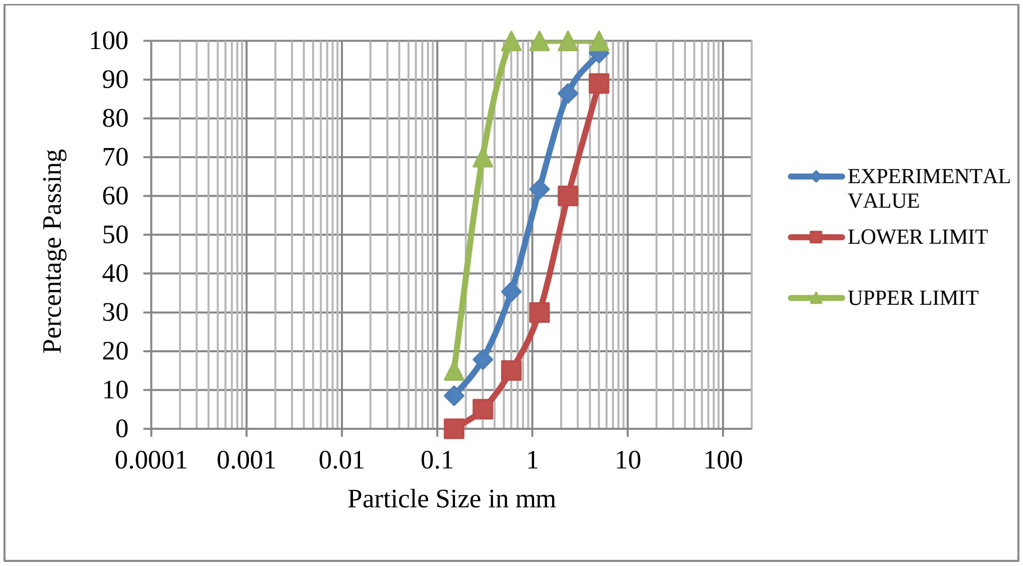

Figure 2: Particle Size Distribution Curve of aggregate for industry B

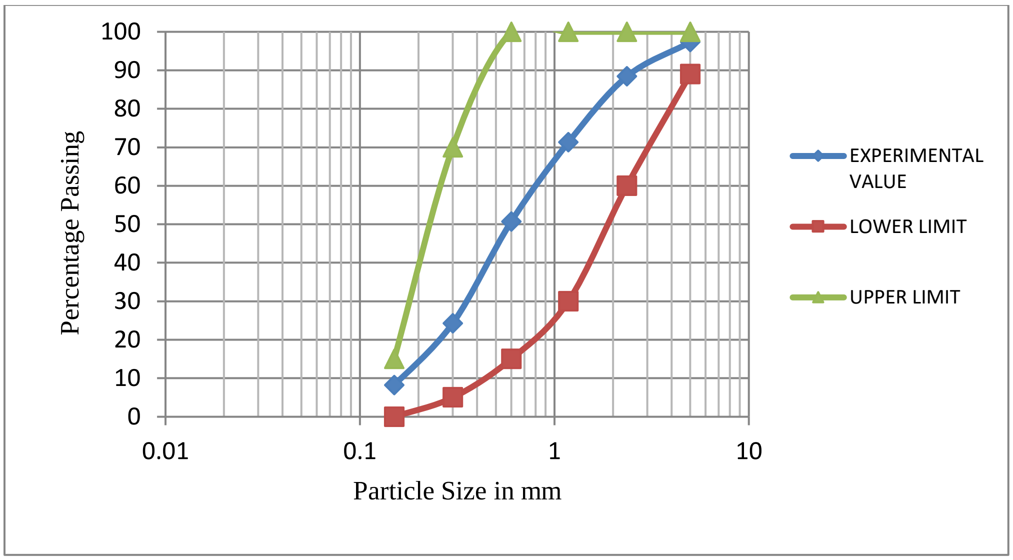

Figure 3: Particle size distribution curve of aggregate for industry C

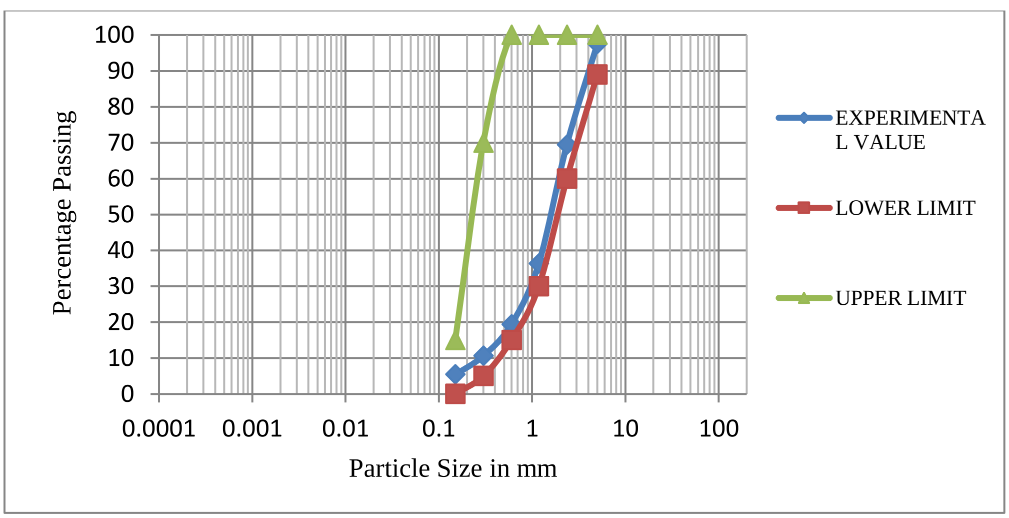

Figure 4: Particle size distribution curve of aggregate for industry D

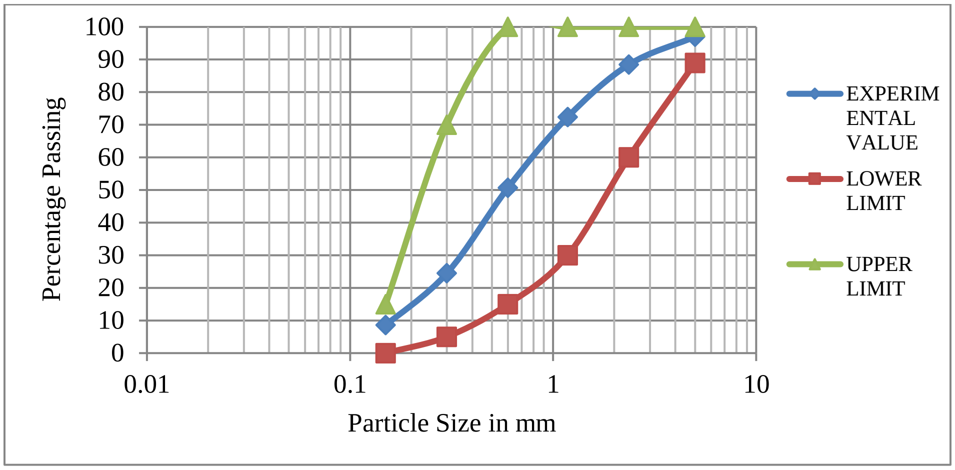

Figure 5: Particle size distribution curve of aggregate for industry E

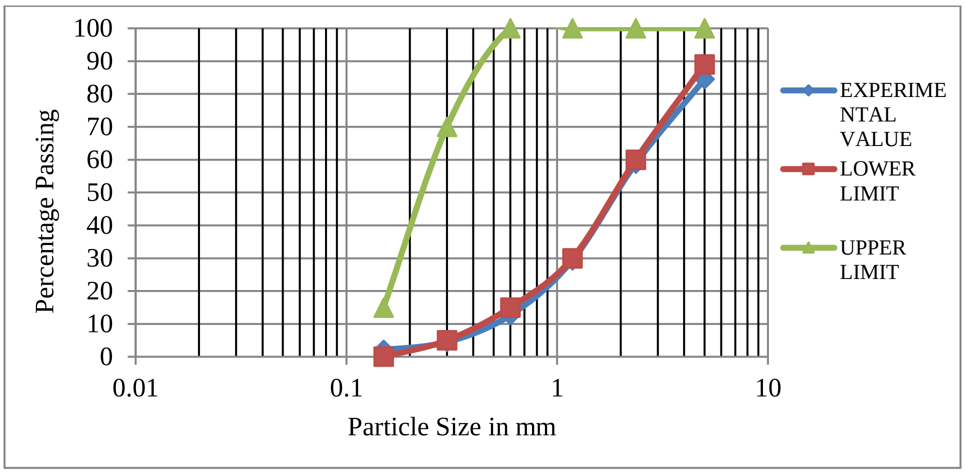

Figure 6: Particle size distribution curve of aggregate for industry F

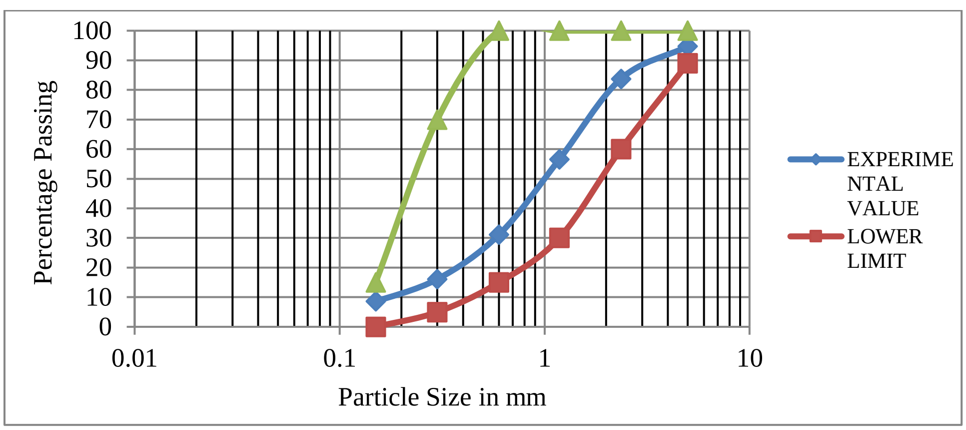

Figure 7: Particle size distribution curve of aggregate for industry G

Compressive Strength Test: The result of the compressive strength of the sandcrete blocks in all the industries is shown in Figure 8. The compressive strength of individual sandcrete blocks ranges between 0.24 N/mm^2 and 1.25 N/mm^2 while the mean compressive strength of five blocks across all the samples ranged between 0.38 N/mm^2 to 0.98N/mm^2. Industry B gave the highest average compressive strength of 0.98N/mm^2 which was followed by 0.63 N/mm^2 of industry G and 0.54 N/mm^2 of industry D. The least strength of 0.39 N/mm^2 was observed on industry C and E while that of industry F was found to be 0.47 N/mm^2.Overall, none of the block industries produced blocks that are comparable to the Nigeria Industrial standard recommendation (NIS 87: 2004) for hollow sandcrete blocks (Machine Vibrated and Hand Mould). The highest value obtained at industry B and the lowest value obtained at industry C and E. These values obtained are below the Nigerian Industrial Standard (NIS 87: 2004) which specified that the lowest crushing strength of individual load bearing blocks shall not be less than 2.5N/mm^2 and 3.45N/mm^2 as the average strength value of the five blocks. These values of compressive strength obtained are quite similar to those obtained by Odeyemi *et al*, (2015) and Agunwamba *et al*, (2016). Also, from the result obtained, it can be seen that the blocks in each of the industries have different compressive strength value; the manner in which these values vary from one another is a clear indication of poor-quality control. The poor mix ratio adopted, poor curing, lack of consistency in the batch, excessive fines in the sand mix can be attributed to these low values obtained.

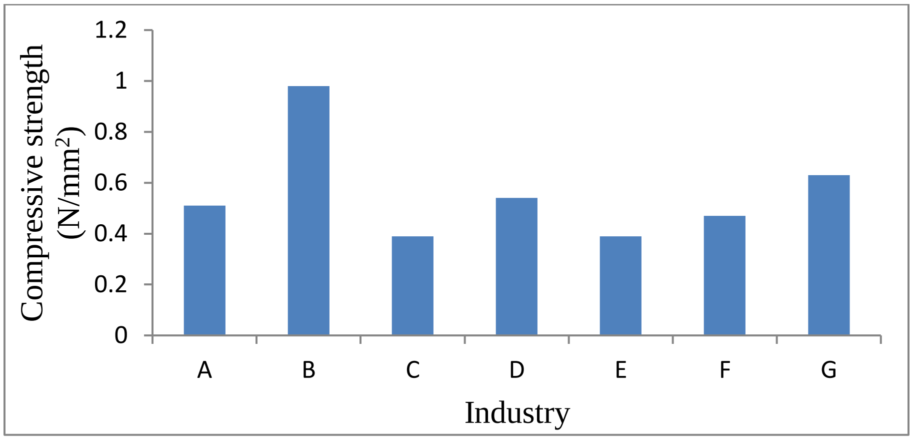

Figure 8: Average compressive strength of sampled blocks

Conclusions and Recommendations

The following conclusions were drawn from the results obtained in study:

(i) The grading properties of the aggregates used in all the industries under study are within the limits specified in BS EN 12620: 2002; hence, the aggregates therefore are suitable for block making.
(ii) Most of the block producers do not adhere to laid down standards of block production.
(iii) None of the block producers have their block size up to (NIS 87: 2004) and none of the compressive strength across all the sampled industries is comparable to the said standard; this can be as a result of poor mix ratio and inadequate curing.

For the improvement on the current block production practice in Nigeria, the following recommendations are made.

(i) Mix ratio of 1:6 as recommended in NIS 87: 2004 should be strictly adhered to;
(ii) Routine testing of sandcrete blocks to comply with standards should be enforced;
(iii) Mechanical mix method is advised for large volume production in order to achieve homogeneous mix which also contributes to the overall strength of the blocks.
(iv) The general public should be sensitized on the danger of using substandard sandcrete blocks, this will to a large extent improve the production of quality sandcrete blocks and promotes the market for the good ones and possibly avert occurrence of consequences of constructing with weak sandcrete blocks such as collapse of walls;
(v) Workshops and formal training should be periodically organized for block producers.

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