CARD International Journal of Engineering and Emerging Scientific Discovery
ISSN: 2536-7250 (Print): 2536-7269 (Online)
Volume 2, Number 3, September 2017
http://www.casirmediapublishing.com

The Importance of Compressive Strength in Sandcrete Block

Sheikh Yusuf, Hamza Aliko & Saleh, M. A.
Department of Civil Engineering
Kaduna Polytechnic, P.M.B. 2021, Kaduna
Email: Ibnyusuf2005@yahoo.com
Corresponding Author: Sheikh Yusuf

ABSTRACT

The compressive strength of sandcrete block is a very important aspect of a block in a building. In many cases of building failures in Nigeria, the strength of the sandcrete block, has been figured as one of the causes of the failure. For this reason, in this research, some blocks were purchased from seven block producing industries in Kaduna Metropolis, and after curing, their compressive strength were determined in the laboratory by crushing them after 7, 14, 21 and 28 days. There corresponding compressive strength are: 0.29, 0.32, 0.38 and 0.45 N/mm^2(for sample 1), 0.35, 0.67, 0.82, and 0.95 N/mm^2 (for sample 2), 0.25, 0.33, 0.39, and 0.48 N/mm^2 (for sample 3), 0.56, 0.68,0.72 and 0.98 N/mm^2(for sample 4), 2.25, 2.45, 2.82 and 2.74 N/mm^2(for sample 5), 0.61, 0.77, 0.82 and 0.96 N/mm^2(for sample 6) and 2.32, 2.46,2.78 and 2.95 N/mm^2 (for sample 7). From the results only sample 5 and 7 have certified the Nigerian Industrial Standard (N.I.S) of 2.5 N/mm^2, for individual blocks i.e.1.7 N/mm^2; and 21 and 28 days results have satisfied the British Standards lowest requirements for individual block. The remaining samples 1, 2, 3, 4 and 6 have not certified any requirement. When the control, with a cement ratio of 1:6 and water/cement ratio of 0.45, was produced and crushed after curing, the following are the results of the compressive strength after curing for 7, 14, 21 and 28 days: 2.82, 3.01, 3.28 and 3.44 N/mm^2. This shows that the control has satisfied the requirements of the N.I.S and the lowest requirement of individual block strength accepted by the British Standards.

Keywords: Sandcrete block, Compressive strength, Curing and Crushing, British Standards

INTRODUCTION

Sandcrete hollow blocks are generally defined as a mixture of sand, cement and water formed in a block making mould. The blocks are supposed to have adequate compaction pressure so that they can be confidently used in building of walls and other structures at various levels during construction (Hamza and Yusuf, 2009). According to Abdullahi (2017), British Standard 6073: 1981 part 2 defines block as a masonry unit of larger size in all dimensions than specified for bricks but no dimension should exceed 650mm nor should the height exceed either its length or six times its thickness. Seeley (1993) defined sandcrete blocks as walling materials that are made of coarse natural sand or crushed rock dust mixed in proportion with cement and water and is moderately compacted into shapes. Sandcrete blocks are available for the construction of load bearing and non-load bearing structures. According to building specifications, load bearing blocks must have appreciable width and adequate crushing load in order to perform satisfactorily while in use. Sandcrete blocks also participate in the task of transforming the actual load from the overlaying structural element to the foundation. In this case, the load bearing walls are those walls acting as supports for the other structural members (slabs and beams) and transfer all loads from superstructure to the underlying foundation. Hollow block is a composition of usually (1:6) mix of cement and sharp sand with the barest minimum of water mixture, and in some cases admixture, molded and dried naturally. Sandcrete hollow block is either produced manually or by moulding machine. The manual production suffers the problem of less compaction and therefore less strength after curing, but the machine moulded block, when produced according to the standards, suppose to attain the required strength. Sandcrete blocks should cope with thermal and moisture conditions, and the problem of algae growth on the face of block work during construction should not affect the strength of the block (Edward, 1985). The compressive strength of hollow sandcrete block increases by adding optimum quantity of water, which will also have an impact on the mix and workability. This means that there is a limit to an increase of water in the mixture during which further increase in water percentage will result to decrease in the strength (George, 1980). Hamza and Yusuf (2009) have explained that the compressive strength in sandcrete block increases sharply with the increase in the ratio of cement content and in the size of the fine aggregate provided they are done according to standards. The strength is normally determined using compressive strength test, while durability is assessed using water absorption test. The compressive strength of sandcrete blocks depends on variables that affect it during production. These include the amount of cement, fine aggregate, water, degree of compaction, the curing conditions, the age of the cement and the type of weather (Raheem, 2006). Also the compressive strength of sandcrete block is affected by mix proportion, mode of manufacture; physical conditions such as curing method and duration and temperature etc. The strength of structure partly depends on its wall. Among the consequences of low compressive strength blocks, are cracks in the buildings and structures due to low strength to withstand the loads. Walls built with poor quality blocks that fail to meet standard often collapse, causing severe damage to structure and loss of lives. In December, 2016, this author and two other colleagues, after on site investigation on building collapse, presented a paper: "Assessment of building collapse in Nigeria in the 18th annual Engineering Conference in Kaduna Polytechnic, Nigeria." The topic is on the collapse of a proposed building for the department of architecture in a state university in northern Nigeria, which is under construction at that time. Among the causes of failures of the structure, is the low compressive strength of the sandcrete blocks found at the site (Hamza *et al.,* 2016). In the production of sandcrete blocks it is very important to ensure proper for mixing cement sand and water and adequate water and time in curing the blocks after manufacturing them. Potable water is recommended for use in the production of sandcrete blocks (NIS, 2000). Cement normally serves as the bonding agent, while sand particles provide the skeleton or particles to be bonded. The bonding action is due to the hydration of cement. The use of sandcrete hollow blocks in building construction, as a walling unit in Nigeria, and in many parts of West Africa is as old as the construction industry itself.

For a long time until perhaps a few years ago, these blocks were produced in many parts of this country without any reference to any specification either to suit local building requirements or for good quality work.

And up to the time of writing this paper, there are still many block production industries that are not complying with the basic standards. This is despite the fact that the government through its agency, the Standard Organization of Nigeria (SON) has come up with a document giving the specification both for the manufacture and use of these blocks in Nigeria. Various researchers have carried out investigations to determine the compressive strength of sandcrete blocks and compare the results with the local (NIS) and international standards (BS) in order to ensure that the standards have been adhered to. Unfortunately, the results of many previous researchers have concluded that the sandcrete blocks produced in Akure, Minna, Owerri, Ondo and Makurdi were all below the local and International standards. Banuso and Ejeh (2008), assessed the quality of sandcrete blocks produced in Kaduna state and concluded that the blocks were of lower quality when compared with the B.S and N.I.S standards. This is a very serious issue and the outcome of these researchers should make the government to take drastic actions by ensuring that standards are been adhered to, and offenders been punished accordingly. Cost of block production materials, especially cement is the major argument presented by the block producing industries as the reason why they are not adhering to the standards.

This and other reasons cannot be compared with the rate of building collapse and deaths that are as a result of failure of sandcrete block to withstand the load imposed on it, due to its less strength to bear the load (Abdullahi, 2005). Most of the production industries do not care to provide adequate enabling environment for the production of sandcrete blocks. They are, in most cases, trying to maximize their profit. The production of sandcrete hollow block was in most cases left in the hands of the illiterates, or people who have no previous knowledge of Civil or Building Engineering, and therefore are ignorant of the basic compressive strength of sandcrete blocks. Cement is the most important material for the production of sandcrete hollow blocks; because it binds the other constituent materials together in the presence of water into a cohesive strong mass.

Sandcrete hollow block is made from the mixture of cement, sand (fine aggregate) and water in a standard specified mix proportion. It has the following nominal standard sizes of:
450mm x230mm x 100mm
450mm x230mm x150mm
450mm 230mm x 230mm (Abdullahi, 2017)

Sandcrete blocks constitute a unique class amongst man-made structural component for building in Civil Engineering work. For example in buildings, walls are constructed (using blocks), as either load bearing or non-land bearing to provide shelter, protection, conveniently divide space, privacy and also to provide security for man and his properties (Edward, 1985). This means that the importance of these blocks, especially its compressive strength cannot be overemphasize, due to their importance in the construction industry. The strength of the block will contribute to the strength of the units used in a structure. For example, walls built with poor quality blocks that falls short of the standard strength are likely to fail, thereby causing severe damage to the structure and sometimes even lost of lives and properties. This shows that there is need to know the compressive strength of blocks.

Form and Size

There are three basic forms of sandcrete blocks: solid, cellular and hollow. A solid block has no formed holes or cavities other than the voids of the constituent materials, while cellular and hollow blocks have one or more formed holes or cavities which in hollow blocks pass right through them. According to Abdullahi (2017), BS 2028: 1970, explained that a block is considered solid when the solid material is not less than 75% of total volume of the block calculated from the overall dimensions. Also a hollow block is obtained when there are one or more large cavities, which pass through the block, and the solid material is between 50% and 75% of the total volume of the block calculated from the overall dimension. A cellular block is formed when the block has one or more moulded cavities, which do not effectively pass through the block and the solid material is between 50% and 75% of the total volume of the block calculated from the overall dimension. In modern construction industries, blocks are invariably hollow. Apart from the economy of material, the hole reduces the risk of interior dampness into the building wall and also improves thermal resistance and heat insulation within the walls (Abdullahi, 2017).

Control

This research work intends to look at the compressive strength of some block production industries in Kaduna and compare the results with the British Standards and Nigerian Industrial Standards. Therefore, a sample of sand was brought from one of the block production site, and control sandcrete block samples were produced, cured and crushed in the laboratory, so that the compressive strength of the control can be compared with those of the block industries whose samples are obtained.

LITERATURE REVIEW

The suitability of sandcrete blocks for use as walling materials is normally assessed using strength and water absorption indices. The Nigeria Industrial Standard (NIS 87: 2000) defined the compressive strength of a sandcrete block as the load at failure in compression divided by the apparent bearing area of the block. The compressive strength of sandcrete materials increases with increase cement content. However, strength alone is not to be taken as an indication of durability BS 3921 (1965). Water absorption and porosity of blocks is also essential, although in most cases it is very difficult to have bricks satisfying compressive strength requirements being deficient in water absorption values. Standard Organization of Nigeria, through the Nigerian Industrial Standards, a regulatory authority responsible for quality control of sandcrete blocks production in Nigeria specified a compressive strength value range of 2.5 N/mm^2 to $3.45N/mm^2$ for a load bearing wall and the value range of 1.8 N/mm^2 and 2.5 N/mm^2 for non- load bearing walls (Abdullahi, 2017). The main constituents used in making sandcrete block are: Portland cement, sand and water. The cement is used because it set and hardens by reacting with water. The chemical reaction is called hydration and the sand aggregate used in making sandcrete block can be either natural or manufactured, and should be completely devoid of organic matter, have little or no cohesion and of high strength. It must also contain sufficient amount of material smaller than 300mm (passing through BS sieve No. 52) so that the mixture can be workable and does not segregate as stipulated in B.S. 2028 (1970) (Hamza and Yusuf, 2009). Sandcrete block should be left to mature for at least 28 days (by curing them) before they are laid, if enough strength is needed. Curing is the process of preventing the loss of moisture from the block while maintaining a satisfactory temperature regime. Preferably, sandcrete block should be moist air cured for the first seven days. Curing and protection usually produce very good blocks and these could be carried out in the following ways.

1. Covering the blocks with wet material such as polythene sheets
2. Spraying the block with water. This could also be form of high-pressure steam curing otherwise known as auto cleaving.
3. The most commonly used out of other forms of curing is the spraying method. (Hamza and Yusuf, 2009).

Curing and protection of sandcrete block should start as soon as compaction is completed. This will protect the block from the following:

- Leaching out by rain and flowing water
- Premature drying out particularly with solar radiation and wind
- Rapid curing during the first few days of moulding or production (Hamza and Yusuf, 2009).

MATERIALS NEEDED FOR MAKING SANDCRETE BLOCKS

Sand

Sand for making blocks could be sourced from various places but the most preferable one is from beds of rivers as the sand is naturally washed and void of impurities like silt which might affect the strength of blocks. In some locations, sand gotten from river beds is mostly sharp and very good for commercial production of blocks as more blocks could be gotten per bag and yet dense and strong enough for use if relevant conditions are taken care of.

Cement

Blocks moulders use Portland cement (e.g. Dangote cement, Sokoto cement, Bua cement e.t.c). In most cases, people preferred a rapid hardening type (of cement), due to the short period it takes to be able to meet customer's demands, Cement binds the other constituent materials together and also fills up the voids in between them in the presence of water. Therefore, it is the most essential constituent material of sandcrete blocks. Neville (1983), stressed the fact that cement binds aggregates together and fills up the voids in between them. It has been observed that Ordinary Portland Cement (OPC) is the most common cement generally used in this country for building construction. Whichever brand of cement is used in the production of sandcrete block, it should meet the following physical properties of cement:

- The soundness expansion should not be more than 10mm and 5mm if aerated.
- The fineness of an average specific surface of not less than 250 cm^2/g
- Initial setting time should not be less than 45 minutes and final setting time of more than 10hrs (Abdullahi, 2017).

Water

Is a major requirement for concrete block production both for moulding and curing. A major requirement of water used for the manufacture of blocks is that it should be free from salt and other impurities. To meet this requirement most block manufacturers have pipe borne water connected to the factory site. Apart from this, the alternative is to hire tankers to supply water from rivers to the site. BS 3148:1980 specifies that, the suitable water for making concrete block should be water that is free from any chemical composition and acceptable for drinking, whether treated for distribution through the public supply or untreated. Sea water has a maximum concentration of 3.5% salts in its compositions; hence it is not advisable to use it as mixing water. Investigations have indicated that the 28 days strength could be reduced by as much as 20% if seawater is used as mixing water. The quality of water affects the hydration of cement and adversely affects the strength of sandcrete blocks. Research has shown that the strength of sandcrete block at a given age depends upon the water/cement ratio. The amount of water used should be the minimum necessary to give sufficient workability for full compaction of the block. When the water quality is in doubt, it is necessary to test both its nature and extent of contamination according to BS 3148:1980 before used. The strength, workability and setting time of sandcrete blocks depend largely on the amount of water used in mixing. Strength of sandcrete blocks increases with decreasing water: cement ratio, while blocks made from too dry mix fracture during discharge (Baiden and Tuuli, 2004).

Water/Cement Ratio

Sandcrete block mixtures are usually specified in terms of the dry-volume ratios of cement to sand. Depending on the applications, the proportions of the ingredients in the block can be altered to produce specific changes in its properties, particularly strength. For high-strength block, the water content is kept low, with just enough water added to wet the entire mixture. The strength of sandcrete block at a given age is assumed to depend primarily on two factors: the water/cement ratio and the degree of compaction. The net water/cement ratio depends on the rate of absorption at the time of mixing and not only on the moisture content of the aggregate. Observation have been made during this research work , that the strength of sandcrete hollow block increased as the water/cement ration increase from 0.45 to 0.50 and decreases as the water/cement ratios increases to 0.65 because of the increase in void content. Therefore the amount of water in a mix must be controlled if high strength quality blocks are to be produced.

Aggregate

The sand to be used for producing sandcrete blocks shall be clean, sharp, fresh water or pit sand free from clay, loam, dirt, organic or chemical matter of any description. The most widely used aggregates for moulding sandcrete blocks is the natural sharp sand usually from the riverbed. The grading for sizes and the shape of particles are important, because they affect the workability of the mix as well as the density and impermeability of sandcrete hollow block. In general, aggregate to be used in any construction work or manufacturing should conform to the standards.

Mix Proportion

The British Standard; BS 2028 (1970) specifies that the mix ratio used for sandcrete hollow block production shall be not richer than one part by volume of cement to six parts (1:6) of combined fine and coarse aggregate except that it may be increased to 1:4 where thickness of the web of block is 25mm or less. Experience has shown that the strength of block decreases with increase in the mix ratio. A research carried out by the authors in this topic, has shown that, the strength of block after 28 days with a mix proportion of 1:4, 1: 5, 1:7 and 1:8 were 0.904, 0.548, 0.259 and 0.176 N/mm^2 respectively. Hence, the richer the mix proportion, the higher the crushing strength of the blocks produced from the mix. Also, if cement content of a mix for sndcrete block production is increased, the strength usually increases, but if the block with a higher cement content was less compacted than the lesser block, then the strength of the rich block may be lower. A block producer confirmed to this author that it is undesirable to use mix proportions richer than the nominal ratio of 1:6 to achieve good quality blocks. Therefore there is no need to exceed the standard mix ratio. It is possible to decrease the cement to sand and still retain the strength requirements of block, provided that well graded sand is used under effective vibration and optimum workability.

Curing

Curing has been described as the process of preventing the loss of moisture from the block while maintaining a satisfactory temperature regime. Adequate curing of block is essential to ensure sufficient hydration of the cement. During curing period, the originally water filled space in the cement – sand mix, is gradually replaced by gel product of hydration. This practice promotes the development of compressive strength and dimensional stability of the block. After the block has been cast, the surface should be kept moist so that it can achieve its maximum strength and not shrink too much due to drying out, which results in cracks. The method of curing employed can significantly affect the properties of the blocks. If curing is efficient, the strength of the concrete block increases with age. This increase is rapid at early ages and then continues more slowly for an indefinite period. Cement curing increases the impermeability and durability of the sandcrete block.

Curing takes place about twenty-four hours after the production of the blocks for about seven days and then allowed to dry slowly. For more strength to be achieved by the block, curing can continue for as long as 28 days (Hamza and Yusuf, 2009).

METHODOLOGY

Control samples of the sandcrete blocks were produced in the laboratory. The sharp sand used in this research was collected from one of the block production industries in Kaduna town. The hollow sandcrete blocks were produced using a machine mould. During the mixing process, the batching was by weight instead of volume. The mix ratio used for cement and sand is 1.6 and a water/cement ratio of 0.45. The water that was used for mixing and curing the blocks is tap water, and pH was within the accepted range and the water is not hard water. After production and curing of the blocks, the blocks were then taken to material and structures laboratory of the Department of Civil Engineering, Kaduna Polytechnic, for crushing. The compressive strength of the total number of 64 blocks (Eight from each of the block industries), plus 8 blocks that were produced in the laboratory as a control were determined after 7days, 14days, 21days, and 28 days respectively.

Survey of the Seven Block Producers

A survey carried out on the seven selected block production industries where samples for this research were obtained in Kaduna has shown that:

1. None of these block producers have concrete mixer. In other words they are mixing the cement, sand and water manually.
2. All the block industries apart from no.7 which has Rosacometre machine with its accessories are moulding the block manually.
3. Almost all of them are using tap water for mixing, but none of them have ever think of taking the water sample to the laboratory for analysis to confirm that the water did not contain impurities. In any case of water shortage, all of them are buying water from local water vendors.
4. Batching is done by volume using wheel barrow. An average of five wheelbarrows of sand is mixed with one bag of 50kg of cement. This

was later measured to about 1:12 mix. That means a ratio of one part of cement to twelve parts of sand materials (1:12) is being used.. The number of blocks produced in a batch of 50kg bag of cement was about 35 number of blocks for 460mm x 225mm x 225mm size and 50 to 60 number of blocks for 460mm x 225mm x 150mm size. Apart from industries 5 and 7, the others don't even care to supervise the mix ratio seriously.

5. Only two of the manufacturers (no 5 and 7) employed persons with technical knowledge of block production. Industry no. 5 has a Supervisor with a Certificate in Building Technology; while no.7 has a Manager that has Diploma in Civil Engineering.
6. In almost all the seven block producing industries, most of the staffs are not even aware of any British Standards or Nigerian Industrial Standards that are related to sandcrete block manufacturing.
7. Curing of the block is done without following any procedure. Apart from block production industries 5 and 7, all others just sprinkle water on the block, 24 hours after production and any day a customer comes (even after a day or two), the block is sold. But industries 5 and 7, are curing their blocks, up to at least 1 to2 weeks.

DISCUSSION OF RESULTS

Graphs in figures 3.0 -3.70 (see appendix) have shown that the compressive strength of the blocks (Samples and Control) have all indicated that the more days the blocks are cured, the more the compressive strength. But looking at tables 1 and 2 (see appendix), it is clear that the compressive strength of samples 1,2,3,4 and 6 have not conform to either the N.I.S or the British Standards for production of sandcrete blocks. However, Samples 5, 7 and Control have satisfied the N.I.S and British Standard minimum compressive strength of individual block.

CONCLUSION AND RECOMMENDATION

Conclusion

Low compressive strength associated with blocks obtained from five of the seven commercial block producing industries, can be attributed to mix proportions used which is far above the standard mix ratio of (1:6) ratio specified, and the water cement ratio values being greater than the upper limit of 0.45. This is has effect the rate of hydration of cement, and resulted in more pores being created in the blocks after the evaporation of excess moisture from the blocks, after the hydration reaction and curing of blocks. Such voids may be responsible for low strength associated with those blocks. Also poor quality control, poor selection of constituent materials and inadequate curing period by the block producers can be some of the causes of low compressive strength values obtained as was also observed. Again, the reasons for the poor results obtained could be adduced to poor selection and storing of materials, as was observed when these researchers visit the sites of these blocks producers.

Almost all of them dump the fine aggregate and stockpiled them directly on unprepared and dirty grounds full of grasses and wood particles and during batching the aggregates and soil materials are scooped together. It is believed that the uncontrolled addition of soil materials which contains grasses, humus soil and wood particles could reduce the quality of the fine aggregate materials. During batching it was also observed that the workers were inconsistent with the mix proportioning. Furthermore, the poor results obtained could be attributed to poor curing method as it was observed that most curing platforms were not covered at the top, a technique believed to assist reduce the high rate of hydration of water at the early age of the product owing to direct exposure. At the same time, the one or two days length of curing period observed were inadequate as compared to the specified 7,14,21,28 days curing period. This inadequate curing period could contribute to the poor development of strength of the products. Since the quality of water utilized in the production of these samples of sandcrete blocks was not tested, the quality of the water used could also impact negatively leading to the poor compressive strength results obtained. That is, the water used for the production could contain deleterious substances in quantities capable of weakening the materials used in producing the blocks.

Recommendations

Based on the results of tests carried out on the samples of blocks produced in some parts of Kaduna Metropolis it has been concluded that these blocks are substandard because the producers did not comply with the NIS and BS standards. Therefore the research recommends:

- ✓ It is obvious that, if fine aggregate materials are properly selected and stored on a well prepared platform that will eliminate or reduce the combing of soil materials during scooping and utilization, good sandcrete blocks could be produced.
- ✓ Also, the batching and mixing of sandcrete materials requires the use of experienced technical personnel engaged to control this important aspect of the work from inception to completion to enhance consistency in proportioning and mixing. It is recommended; that before a person is appointed as a Supervisor or Manager, in a block production industry, he should at least have a minimum qualification of Diploma in relevant field of Engineering and some years of experience.
- ✓ Sandcrete blocks manufacturers in Nigeria must be constantly enlightened by the NIS and/or Nigerian Society of Engineers (N.S.E) and other stakeholders in the industry on the importance and the need to adhere to the NIS specified days of curing period for produced sandcrete blocks which must be laid under a properly prepared environment and platform that will reduce the higher rate of hydration of water and lower strength development observed. An in-house workshop should be organized on regular basis in order to sanitize the technical staff on the need to adhere to specifications.
- ✓ Agencies like Standards organization of Nigeria (SON), NSE, COREN, can schedule regular unscheduled visits to these industries from time to time so that they can ensure that specifications are adhered to. And should in case any block production industry is found

not adhering to specifications, the government should close the industry and punish the offender accordingly. This will serve as deterring warning to others.

- ✓ The compressive strength of the control can be improved if clean sharp sand is used and the water/cement ratio of 0.5 is used instead of the 0.45 used in this research.

REFERENCES

Abdullahi, A. B. (2017): Sandcrete Block Production in parts of Plateau State. Unpublished M.Sc Thesis. Department of Civil Engineering, Ahmadu Bello University, Zaria (2017).

Abdullahi M. (2005): Compressive Strength of Sandcrete Blocks in Bosso and Shiroro Areas of Minna, Nigeria AU Journal of Technology, volume 9 no 2, 2005, pp 126 – 132

Baiden, B. K. and M. Tuuli. (2004): Impact of quality control practices in sandcrete blocks production, Journal of Architectural Engineering, 10(2), 55-60.

Banuso O. R. & S. P. Eeh (2006): Assessment of quality of sandcrete blocks in Kaduna state –Nigeria. Journal of Construction Vol 2 No.1.

British Standards (BS) 3921. (1965): Bricks and Blocks of earth caly or shale. British Standard Institute, London.

British Standards (BS) 2028., (1970): Precast concrete blocks. British Standard Institute, London.

British Standards: 3148; (1980): Method of test for Water for making Concrete, London, England.

British Standards (BS). 6073. (1981): Precast concrete masonry units part I: specification for precast concrete masonry Units; part II: methods for specifying precast Masonry units. British Standard Institute, London.

Curtin W. G, Shew G., Bray W.A. (1982): Structural Mansory Designers Manual, BSP Proportional Books, Oxford-London, (Second Edition) Pp 439 – 442

Dhir, .J (1980): Civil Engineering materials. Macmillan, London. 5th edition Pp 493-526.

Edward, A. (1985): Foundation of building construction, materials and methods. Macmillan, London. 2nd edition. Pp 242-246.

George, C. (1980): Construction Technology Guide. Volume 2. Northwood Book, London. Pp 40-43.

Hamza, A. A. and Yusuf, S. (2009): Determination of compressive strength of six inches hollow sandcrete block. A paper presented at 12th annual National Engineering Conference, College of Engineering, Kaduna Polytechnic, Kaduna. 1st to 3rd December, 2009.

Hamza, A. A, Yusuf, S and Saleh, M.A (2016): Assessment of Building Collapse in Nigeria: A Case of Kano State University Building, Wudil. Nigeria. Being a Paper Presented at the 18TH Annual National Engineering Conference, Kaduna Polytechnic , Kaduna.6th -7th December, 2016.

Nigerian Industrial Standard (NIS), 87. (2000): Standard for Sandcrete bricks, ICS, 91.10.20, NIS; Abuja, Nigeria.

Raheem, A. A. (2006): "Comparism of the Quality of Sandcrete Blocks Produced by LAUTECH Block Industry with others within Ogbomoso Township", Science Focus, Vol 11 (1), pages 103-108.

Seeley, I. H., (1993): Building technology (4th edition). Macmillan Press Limited, London.

APPENDIX

Table 1: Summary of Average Compressive Strength of Block Samples

	Compressive strength of samples (N/mm²)						
Curing days	1	2	3	4	5	6	7
7	0.29	0.35	0.25	0.56	2.25	0.61	2.32
14	0.32	0.67	0.33	0.68	2.45	0.77	2.46
21	0.38	0.82	0.39	0.72	2.58	0.82	2.78
28	0.45	0.95	0.48	0.98	2.74	0.96	2.95

Table 2: Average Compressive Strength of Control

Curing days	Compressive Strength of Control (N/mm²)
7	2.82
14	3.01
21	3.28
28	3.44

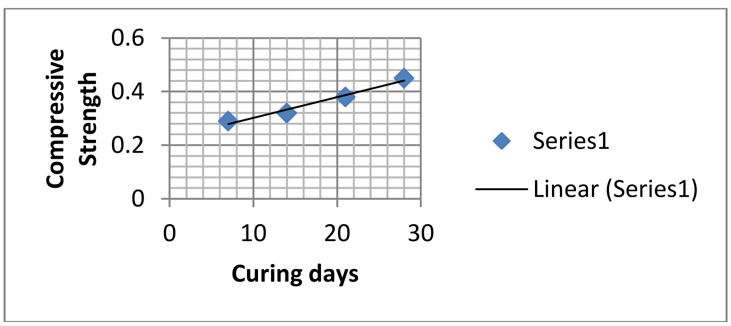

Fig 3.0: Compressive Strength versus Curing days of Sample 1

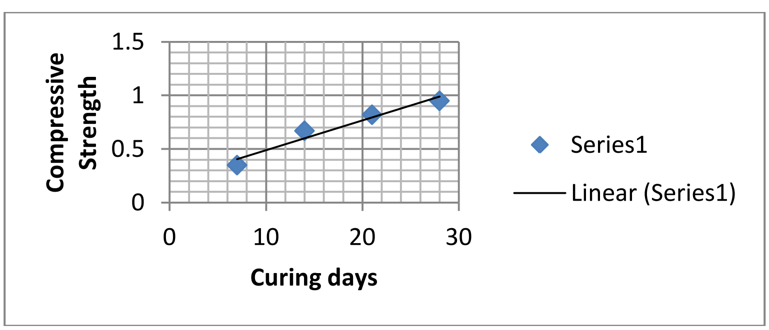

Fig. 3.1: Compressive Strength versus Curing days of Sample 2

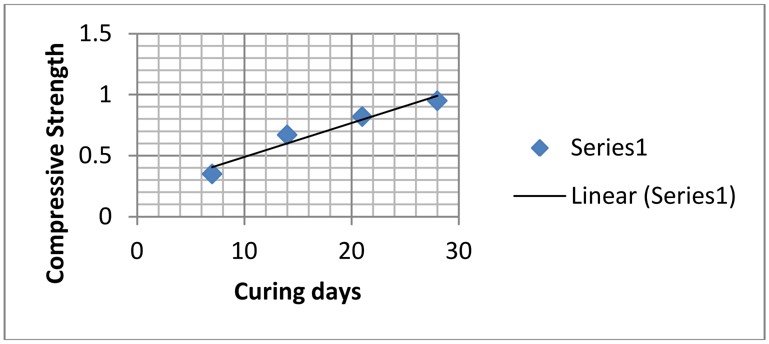

Fig. 3.2: Compressive Strength versus Curing days of Sample 3

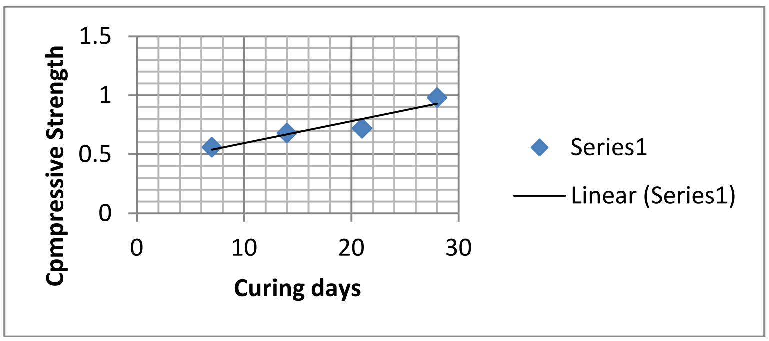

Fig. 3.3: Compressive Strength versus Curing days of Sample 4

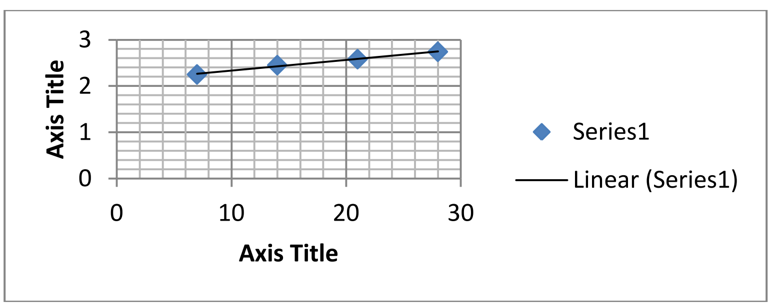

Fig. 3.4: Compressive Strength versus Curing days of Sample 5

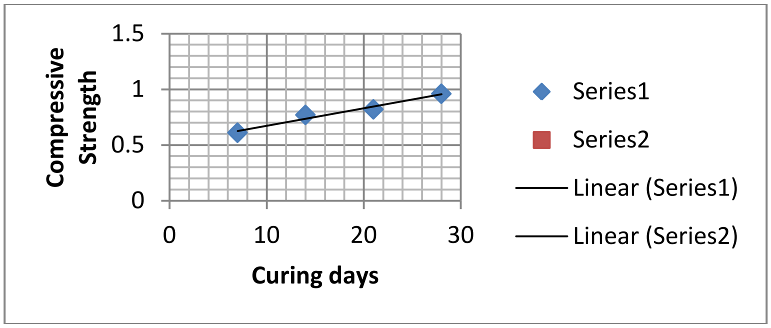

Fig. 3.5: Compressive Strength versus Curing days of Sample 6

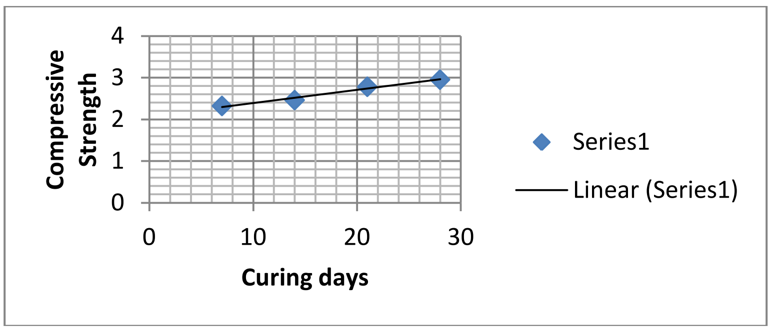

Fig. 3.6: Compressive Strength versus Curing days of Sample 7

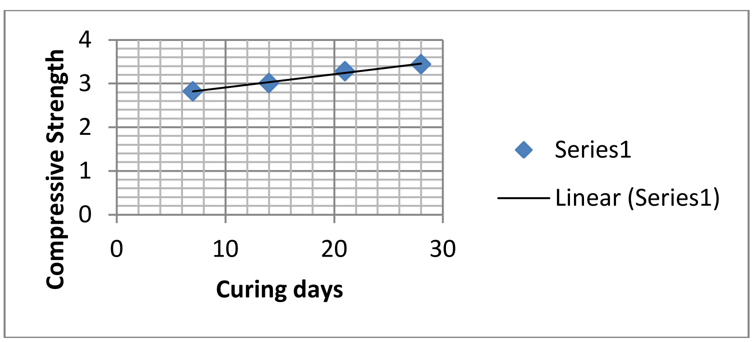

Fig. 3.7: Compressive Strength versus Curing days of Control