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An Appraisal of the Quality Control Practices in Sandcrete Blocks Production in Yewa South Area of Ogun State, Nigeria

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***Abstract*: -** The paper focuses on the appraisal of quality control practices by commercial block manufacturers on the quality of blocks produced in the Yewa South Area of Ogun State, Nigeria. Both visual inspection and laboratory testing were adopted as the means of ascertaining the quality of blocks produced. Block production sites were visited for physical inspection to assess their conformity with block production processes as stipulated in relevant codes and standards. Samples of Sandcrete blocks were collected from block manufacturers and tested for dry density, water absorption, volume porosity, moisture content and compressive strength. Control experiment was set up to obtain desirable result when production is done according to laid down procedures. The study confirmed that the staff of contractors had no formal training in quality control of block production and that mix ratio, quality, and mixing of the constituent materials as well as curing method affected the quality of sandcrete blocks. It was also confirmed that the quality of blocks produced by commercial manufacturers does not conform to the required standard in BS 2028 of 1970.

Keywords: - *Quality control, production processes, visual inspection, laboratory testing, sandcrete blocks.*

I.INTRODUCTION

There are three basic necessities of life, food, clothing and shelter, the latter being the most lacked in the society today especially in developing countries. A visit to major towns and cities in Nigeria reveals that people live in over-populated houses and rooms. In Lagos, for example, there are reported cases of a single family of ten members living in just one rented room, while many other people sleep in garages, under kiosks and bridges. This is as a result of their inability to have a building of their own and they cannot afford the exorbitant amount of renting a place of abode. It was stated by [1] that one of the major challenges and problems identified in the developing countries in this twenty first century is provision of shelter. He further said that there is the need to make housing affordable and accessible to the people so as to overcome this challenge.

According to [2], block is defined as a masonry unit of larger size in all dimensions than that specified for bricks and not exceeding 650mm in all dimensions of height, length or thickness. There is no specified unit for voidage relative to volume but external shell wall thickness should not be less than 75mm or 1.75 of nominal maximum size of aggregates which ever is greater. Sandcrete blocks are defined as a permanent durable material which is produced from natural sandy soil or a modified sandy soil such that cohesion of the freshly moulded blocks is insufficient to allow the unsupported handling or curing. Block depth may be greater than 100mm, typically, 230mm with the use of dynamic compaction for producing more common uniform compaction resulting in insufficient strength for the block to retain its moulded shape though not enough for unsupported handling or stack curing. Sancrete blocks refer to blocks made or moulded with sand, water and cement which serve as a binder. It possesses an intrinsic low compressive strength hence its susceptibility to seismic activity. It is a major component material in the construction of buildings in Nigeria and many other countries in Africa [3]. Previous research conducted has revealed dismal production result of commercial sandcrete blocks which exhibit compressive strength far below standardized strength for construction [4]. This is due to the apparent simplicity and relatively low cost in setting up of block making factories which requires no formal qualification judging from the proportion of the population that constitutes the bulk of the operators.

It was equally said that "the quality of products and services is the major concern of every consumer and producers" [5] and [6]. According to [7] quality means compliance with specifications while [8] stated that quality may be viewed as the totality of features required by a product or service to satisfy a given need. The affirmation of [9] was that there is conflict relative to opinions about the concept of quality while [5] postulates that for quality, the building owner has an implicit expectation of quality for his/her building; the designer has his/her own professional view of quality depending on architectural and engineering tradition and the manufacturers and constructors have to make judgements about quality as it relates to price while on the other hand, stipulated codes and regulations impacts on projects, with a view of quality, which may itself conflict with those of other participants. They further stated that the result of all this confusion is very often a frustrated client, a disillusioned designer, a commercially embarrassed contractor and distrusted manufacturers. They concluded that quality is a summation of all those characteristics which together make a product acceptable to the market.

The position of [10] was that for a long time until perhaps a few years ago, these blocks were manufactured without any reference to any specification either to suit local building requirements or for good quality work. They further observed that the situation has since changed as the standard organisation of Nigeria now has a document in place giving the specifications both for the manufacture and use of standard sandcrete blocks. However the high and increasing cost of the constituent materials especially cement has resulted in compromise on the quality of commercial block production as manufacturers resorted to sharp practices in block production processes by lowering the mix ratio of constituent materials. However, [11], confirmed that mix ratio, materials quality, and mixing of the constituent materials affect the quality of sandcrete blocks. While [12] observed that blocks which have high coefficient of variation is an indication of very poor quality control in the production process. Block production process was one of the three major influencing variables that can affect the properties and long-term performance of sandcrete blocks. The other two major variables of equally significant influence were identified as quality of constituent material as well as the action of environmental agents.

The aim of the paper is to appraise the quality control practices of block producers in Yewa South Area of Ogun State, Nigeria with a view to proffering solution to the production of poor quality blocks in the area.

II.MATERIALS AND METHODS

Constituent materials used in the production of samples of sandcrete blocks tested in the laboratory are: Ordinary Portland Cement (OPC) from West African Portland Cement Company, Ewekoro in Ogun State whose properties conform to [13], well graded sand with a continuous or dense gradation, of low plasticity index and free from clay, loam, dirt, soluble salts and organic or chemical matter which can have harmful effects on OPC both during hydration and even after hardening and fresh, colourless, odourless and tasteless portable water. The mix proportion being used by commercial block producers in all the sites visited varied from 1:10 to 1:12**.** No definite water - cement ratio was used in all the sites visited, water was being added randomly as deemed fit by the operators. Compression of the damp soil and stabiliser mix was done mechanically by the commercial block producers where block samples were collected. While curing of green blocks was done by spraying or sprinkling of water in the morning and in the evening for two days in an open place. Laboratory based experiments were planned for in the research methodology mainly to test ideas, theories and designs that had been formulated. For all laboratory tests attempts were made to ensure that the results obtained satisfied three basic conditions: accuracy, reliability and reproducibility. Only standard methods were used in the production of sandcrete blocks. Inspection of production sites was carried out with the objective of assessing the organisational set-up of the site, and to compare individual production sub-processes against a pre-prepared check-list of good practice. Departures from the norm were carefully noted. Two production sites each were visited at Idiroko and Ilaro respectively for this exercise At both locations, there was no centralised yard for mixing, proportioning, etc. The preparation of specimen for the control experiment was carried out with careful selection and proportioning of constituent materials. All necessary precautions were taken so as to obtain quality product for testing and by inference a desirable result from the test procedures. The planned experiments demanded that specimens be prepared to a high degree of accuracy, reliability and consistency. Extra care had to be taken at all stages of the block production process: soil preparation, mixing, compression, and curing of the samples. Specimen design and preparation describes the procedures adopted and the precautions taken to produce the required number of block specimens for the various tests planned. The description is based on the four main stages of sandcrete block production: soil preparation, mixing, moulding and curing.

Six separate tests and experiments, all of which have direct bearing with the investigation of the effect on the durability of blocks, were selected and conducted. The bulk properties identified as likely to influence durability of sandcrete blocks include: Block dry density (BDD), Total water absorption (TWA), Total volume porosity (TVP), Moisture Content (MC), Wet compressive strength (WCS), and Dry Compressive strength (DCS).

Each of these properties are investigated in this study.

III.RESULTS AND DISCUSSION

The results obtained from the various tests carried out are presented below. In Fig. 1 is the dry density of the blocks for both the commercial samples and the control experiment, Fig. 2 presents the result of the total water absorption for both the commercial samples and the control experiment, while Fig. 3 contains the result of the total volume porosity for both the commercial samples and the control experiment. Fig. 4 has the result of the moisture content for both the commercial samples and the control experiment while Figs. 5 and 6 contains the results of the wet compressive strength and the dry compressive strength respectively for both the commercial samples and the control experiment. From the responses to the pre-prepared check-list of good practice administered at the four block production sites visited the following were deduced:

The concept of batching is not closely followed so there is the likelihood of wastage and misuse of the stabiliser. Also batching of constituent materials is by volume and not by weight and moisture content test was not carried out on the sand used hence no compensation is made for bulking. All the commercial block producers used different mix ratio ranging from 1:8 to as lean as 1:12 (cement sand). Measuring out of the soil mix fed into the mould is not strictly done hence the high level of variation in the dry density of tested block samples. No special attention was given to the corners and edges of green blocks. Curing conditions were not categorised into wet and dry stages as curing was done under direct sunshine by spraying water on moulded blocks daily for two to four days before the blocks are stacked for sale. Blocks were apparently used earlier than the specified curing periods of 28 days required for the OPC. There was no quality checks carried out on the constituent materials used in block production in all the sites visited. The soil used for sandcrete block production was not graded. Quality of water used for mixing and curing were not determined. Laboratory tests such as dry density, water absorption, volume porosity water content and compressive strength tests which are the hall marks of good quality sandcrete blocks were not carried out. These shortcomings are likely to compromise the quality of blocks produced. Experimental results on BDD reveal that for the commercial samples, 150mm hollow blocks have the least value of 1614kg/m^3, followed by 225mm hollow blocks which has 1650kg/m^3. For the control experiment, 150mm blocks have 1806kg/m^3 while 225mm hollow block has the highest value of 1822kg/m^3. (see Fig. 1). The values obtained experimentally for the various types of blocks in this study fall within the range of recommended value for concrete blocks as stated in [2]. It is also pertinent to state that the densities of all blocks tested (both commercial samples as well as the samples for the control experiment) falls within the range of type A blocks [14]. There is not much difference in the values obtained in the control experiment whereas there is a higher level of variation in the commercial samples. This could be as a result of the fact that due process was not followed in the production of commercial samples and there was no quality control.

The results of the TWA values shown in Figure 2 compare well with current recommended maximum values for sandcrete blocks. The recommended maximum is 15% [15]. Although this value is neither absolute nor widely adopted by other researchers, it still serves as a useful purpose. The values obtained were favourable when compared with those of like materials (clay bricks 0 to 30%; concrete blocks 4 to 25%; calcium silicate bricks 6 to 16% [16] see Figure 2. According to [17], TWA values below 7% are regarded as being low, while those above 12% as high. The values for all collected samples from the commercial manufacturers are slightly higher than 12% and as such can be regarded as high while for the control experiment the values for the hollow blocks falls within the range and can be regarded as low. There are marked significant differences in the values of the collected samples and that of the control experiment (see Fig. 2). This can be attributed to lack of adherence to specified procedure by the commercial block producers as there was no specified water/ cement ratio and also the curing process was not properly carried out. The above results also confirm that sandcrete blocks have the potential to absorb appreciable amounts of water and possibly retain it too. The total volume porosity values are lower in commercial samples than that of the control experiment as shown in Fig. 3. The values for both categories of blocks however compare well with those of like materials. Materials with TVP above 30% are considered to be of high porosity [16]. All the blocks examined during this research can therefore be considered to be of low porosity which proves that the TVP for all samples are acceptable (see Fig. 3). The moisture content of the commercial samples show a considerable range of variation and the values obtained are also considerably lower than the recommended values in literature (see Fig. 4). This is perhaps due to the fact that there was no specified water cement ratio and the fact that poor curing process was followed. It can thus be adduced to be responsible for the higher value of water absorption which is an indication of poor quality block. For the control experiment, the obtained values are closer to the recommended value of 80kg/m^3 [18] (see Fig. 4). The corresponding values obtained for water absorption is considerably low, an indication of a better quality block than those obtained for the commercial samples.

The values of the mean Wet Compressive Strength (WCS) in the commercial samples ranged between 1.48N/mm^2 and 1.68N/mm^2 while the values for the control experiment were 6.61mm^2 to 7.18N/mm2(see Fig.

5). The equivalent values of their dry compressive strengths ranged between 2.37N/mm^2 and 2.61N/mm^2 for the commercial samples and 7.27N/mm^2 to 8.09N/mm^2 for the control experiment. (see Fig. 6). The results for the commercial blocks compare well with results obtained by earlier researchers and conforms with the recommendation that the ratio of the mean dry and wet compressive strength in sandcrete blocks should not be greater than 2 [19]. The ratio in the commercial samples range between 1.55N/mm^2 and 1.60N/mm^2 and is much higher than the corresponding values obtained in the control experiment which ranges between 1.10N/mm^2 and 1.13N/mm^2. The result of the compressive strength indicates higher values for the control experiment than the commercial samples (see Figs. 5 and 6). The wet compressive strength for the commercial samples is far below the recommended value for the grade of their densities.

IV.CONCLUSIONS AND RECOMMENDATIONS

From the various reports and experimental results the following conclusions can be drawn: Commercial block producers are ignorant of the existence of any relevant code or specifications relating to block production and properties, as a result, standard process of production and quality control are not ensured. The consequence of this is the production of low quality blocks. This is equally responsible for the marked significant difference in the results obtained from the collected samples and that of the control experiment. The dry densities of all samples tested whether the fall within the category of type “A” blocks according to the specification of [14]. While there is significant variation in the values obtained in the commercial samples, there is no significant difference in the values of the control experiment. The values obtained for the water absorption capacity of the commercial samples is higher than that of the control experiment, although all the samples are within the specified range and compares favourably well with recommended values for other like materials. The total volume porosity ratio is higher in commercial samples than the control experiment; however all the samples are within the specified range and compares favourably well with recommended values for other like materials. The moisture content of the commercial samples show a considerable range of variation and the values obtained are also considerably low. For the control experiment, the obtained values are closer to the recommended value of 80kg/m^3 [18]. Both the wet and dry compressive strength of the commercial samples fall below the recommended values for type “A” blocks for the equivalent value of the recommended densities [14] while the values for the Control experiments are above the recommended values in [14].

From the discussions and the conclusions drawn above, the following recommendations are presented. The Nigerian Building Code of practice should be made available to all stakeholders in the construction industry. Nigerian Building Standard Enforcement Agency (NBSEA) should be set up and empowered like the NAFDAC to ensure conformity of all stakeholders in the construction industry to specified standard of labour, materials and workmanship. Compulsory and regular organised workshop and training on quality control practices in block production processes should be arranged for all stakeholders in the construction industry.

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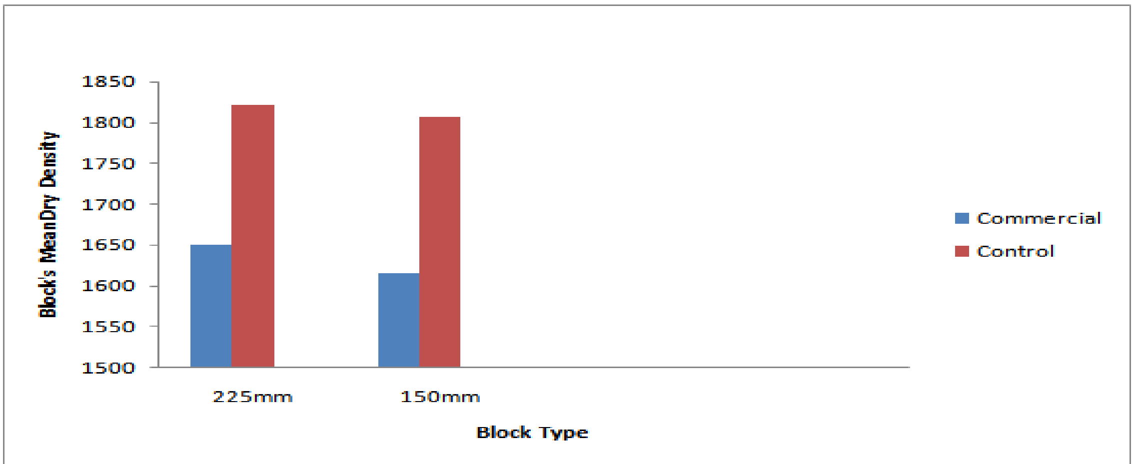

Figure 1. Dry density of blocks

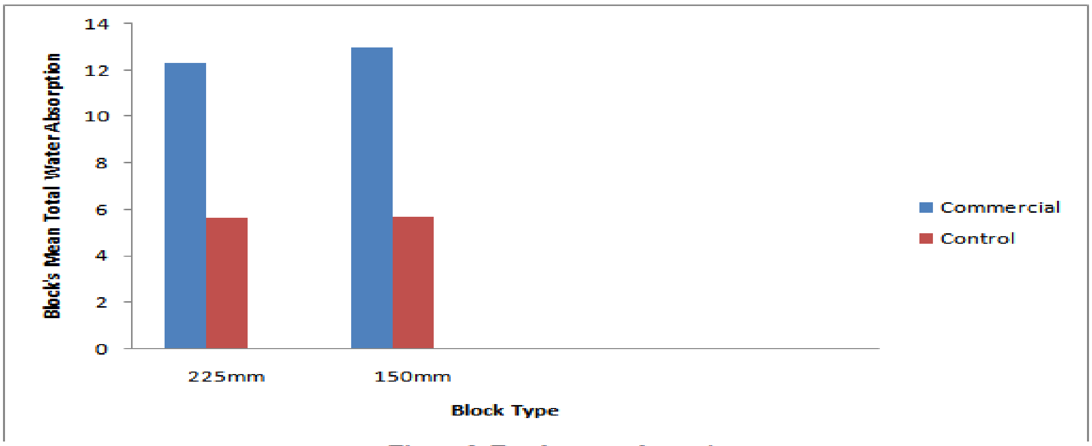

Figure 2. Total water absorption

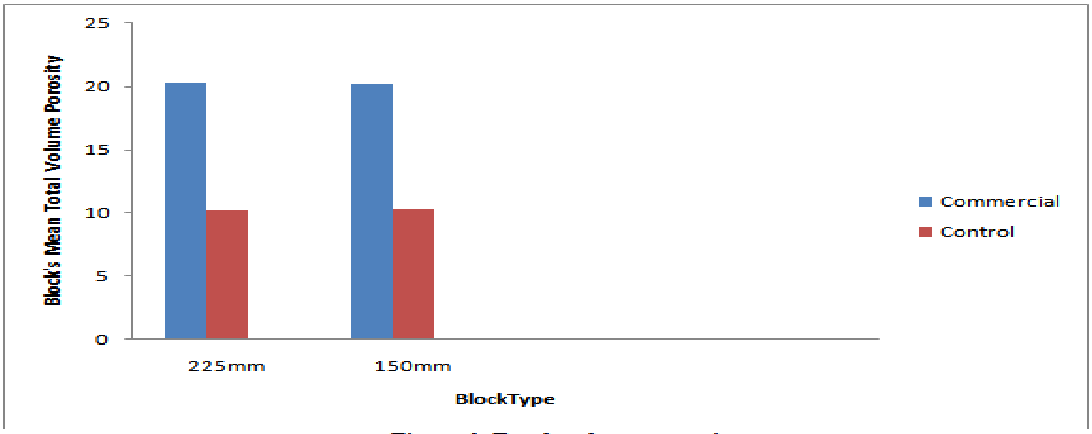

Figure 3. Total volume porosity

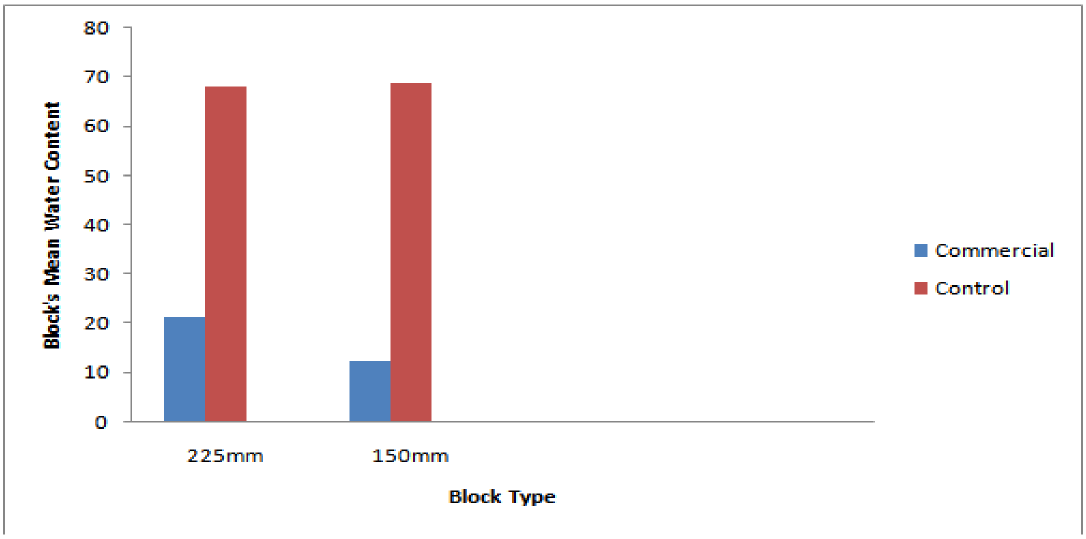

Figure 4. Moisture content

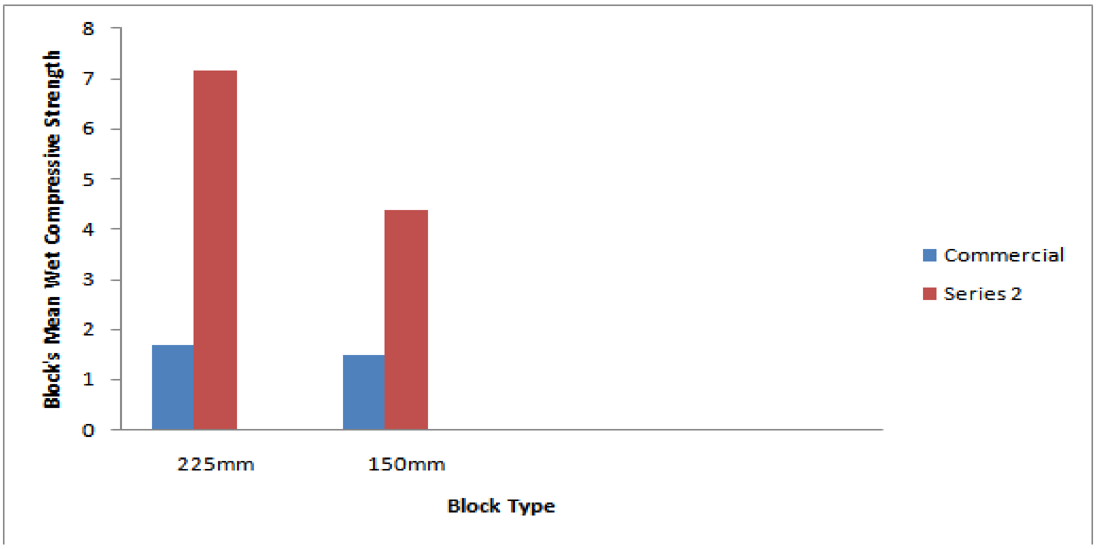

Figure 5. Wet compressive Strength

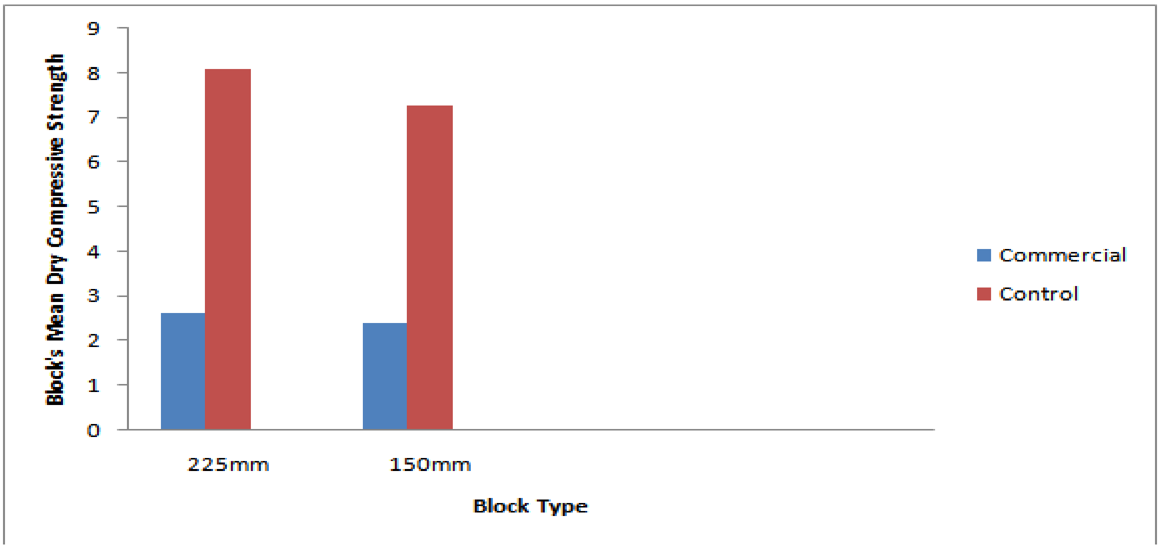

Figure 6. Dry compressive strength