STUDY OF SANDCRETE BLOCK MIXES WITH PARTIAL REPLACEMENT OF SAND WITH QUARRY DUST

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Abstract
This paper provides the result of an experimental investigation into the replacement of sand with quarry dust in production of sandcrete blocks using mix ratio of 1:6. Physical properties of sand and quarry dust were determined in the laboratory in accordance with BS 1377(1997). Blocks were produced manually using 0, 5, 10, 15, 20, 25 and 30% partial replacement of sand with quarry dust. Compressive strength tests were carried out on the blocks after curing for 7, 14, 21 and 28 days respectively. It was found that adequate compressive strength was achieved at 15% replacement with quarry dust corresponding to compressive strength of 1.84N/mm^2.
Keywords: Compressive strength, Density, Mixes, Quarry dust, Sand and Sandcrete blocks.

Introduction

Sandcrete blocks are usually moulded from constituents of sand, water and Portland cement in specified or prescribed mix ratio or proportion. Sandcrete blocks constitute unique class amongst man-made structural component for building in civil engineering works. For example in buildings, walls are constructed of sandcrete blocks, as either load bearing or non-load 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 cannot be overemphasized, due to their usage in the construction industry. The compressive strength of sandcrete blocks is affected by the mix proportion, quality of material used in making them, size, shape, and the mode of manufacture (i.e. hand or machine mould). Physical conditions such as method and days of curing, duration of time, temperature etc will also contribute to the strength of the block (Hamza and Yusuf, 2011)

The strength of the blocks used will contribute to the strength of the units in a structure. For example, walls built with poor quality blocks that fall short of the standard strength are likely to fail, thereby causing severe damage to the structure and some times even lost of lives and properties. This shows that there is need to know the compressive strength of blocks. And in order to minimize the huge loss of money by the block users in the course of handling and transporting substandard blocks. Standard information on the mix proportion and the quality of materials to be used in achieving the desired strength of structure, will certainly be useful to block manufacturers, block users and building designers (Nene, 2009). The blocks that will be discussed in this paper are hand moulded 150mm × 225mm × 450mm blocks.

Quarry dust has been used for different activities in the construction industry, such as road construction, and manufacture of building materials, such as lightweight aggregates, bricks, tiles and autoclave blocks. Researches have been conducted in different parts of the world, to study the effects of incorporation of quarry dust into concrete. Galetakis and Raka (2004) studied the influence of varying replacement proportion of sand with quarry dust (20, 30 and 40%) on the properties of concrete in both fresh and hardened state (Neville, 2002).

Safiuddin et al. (2001) investigated the influence of partial replacement of sand with quarry dust and cement with mineral admixtures on the compressive strength of concrete (Gambhir, 1995), whereas Celik and Marar investigated the influence of partial replacement of fine
aggregate with crushed stone dust at varying percentages in the properties of fresh and hardened concrete.

Blocks are those building unit used in the construction of wall and partitions. They are of sizes and weights that can be easily handled by the bricklayer, with the facing surface layer than that of a brick but conveniently dimensioned. Sandcrete blocks are available for the construction of load bearing and non-load bearing structures (Hodge 1971). Load bearing blocks must conform to building bye laws as regard to their crushing and to the amount of solid mineral contained in section e.g. the total width of block. Sandcrete blocks also participate mainly in the task of transforming the actual load from the overlaying structural element to the foundation. In this case the load bearing wall are those walls acting as supports for the whole structure to transmit the weight to the ground surface underneath it for stability (NIS 87:2000). Sandcrete blocks possess an intrinsic low compressive strength making then susceptible to

any tragedy such as seismic activity. Previous researches show dismal results in the production of sandcrete blocks which had exhibited compressive strength far below the standard requirement for the construction of houses but more viable option would be the use of bricks in the construction of houses (Abdullahi M, 2005)

In this investigation the use of quarry dust as partial replacement of the fine aggregate (sand) in the mortar matrix was for the purpose of enhancing the strength characteristics of sandcrete blocks. Quarry dust is readily available at limestone quarries and it is extensively used in Nigeria in the manufacturing of concrete. Furthermore, granite coarse aggregate has been found to produce higher strength concrete than washed gravel. The present research is aimed at studying the effect of quarry dust addition in sandcrete blocks production and to assess the rate of compressive strength development at different quarry dust to sand replacement.

Some of the objectives are; to determine the index properties of sand and quarry dust, to produce sandcrete blocks with 0,5,10,15,20,25,30,35,40,45,and 50% of quarry dust, to cure the blocks for 7, 14,21 and 28 days and to carry out compressive strength tests on the blocks.

MATERIALS AND METHOD

Materials used in this test are:

Cement;

The cement was bought from Usmaniyya Nigeria Ltd cement depot located at Gbakungu Minna, Niger state, Nigeria. Were cement was kept on a raised platform and adequately protected from external damage by weather. The cement referred to in this work is the Ordinary Portland cement produced from Dangote group of company in accordance to BS 12.

Sharp sand;

The sharp sand was obtained from a river bed at Gidanmangoro, Minna, Nigeria. The sand is clean and sharp, free from clay, loam, dirt or organic matters and conforms to the grading requirement in zone 4 (BS 882:1978).

Quarry dust;

The quarry dust was collected from Abubakar Umar Investment Ltd (quarry site) located along Anguwandaji by-pass Minna, Nigeria. The aggregate was clean and sharp, free from clay, loam, clay, loam, dirt or organic matters and conforms to the grading requirements in zone 2 (BS 882:19 78).

Water;

The water used was obtained from the borehole at convocation square Federal University of Technology Minna (Gidan kwano Campus). The physical examination of the water revealed that it was clean, free from deleterious materials and fit for drinking as recommended by BS 3140.

Production of Sandcrete Blocks

One hundred and forty (140) 150mm ×225mm×450mm sandcrete hollw blocks were produced manually and cured for 7, 14, 21 and 28 days respectively. Twenty (20) numbers of blocks were produced at each replacement level using the mix ratio of 1:6 (cement: sand/quarry dust). During the mixing process, the batching was by volume which is the most common method used for block production of hollow sandcrete block using hand mould. The weight and compressive strength of the thirty five (35) number of blocks were determined at each curing day.

Compressive strength test

Compressive strength test on the block samples was determined using the standard procedure for pre-cast concrete blocks. The weights of the block sample were always taken before the compressive strength test was conducted. Thirty Five (35) blocks sample were crushed at each curing day for the period of 7, 14, 21 and 28 days after casting, using manual 150KN compressive strength testing machine in the Laboratory of Civil Engineering, Federal University of Technology, Minna, Nigeria.

Curing

Curing is the name given to the procedures used for promoting the hydration of cement and thus development of strength of concrete, the curing procedures being control of the temperature and of moisture movement from and into the concrete. The objective of curing at normal temperature is to keep concrete saturated, or as nearly saturated as possible, until the originally needed water filled space in the fresh cement paste has been occupied to the desired extent by the process of hydration of cement. The necessity for curing arises from the fact that hydration of cement can take place only in the water filled capillaries. This is why loss of water by evaporation from the capillaries must be prevented (Neville and Brooks, 2008). However, the method of curing used for this work was spraying method. Thus spraying was done morning and evening for five days.

Results and Discussion

Sieve Analysis

The property indexes of the aggregates used for this work are summarized in table 1. The particle distribution curve indicates that the quarry dust was well graded and classified in zone 2 in accordance with BS (1978) classification for aggregate. Whereby the sand was uniformly graded and classified in zone 4 in accordance with BS 882(1978) classification for aggregate. The values of their specific gravity as shown in table 1 fall

within the limit for natural aggregate (Naville, 1995). Also the compacted and uncompacted bulk densities of both aggregate are shown in table 1. The density depends on how densely the aggregate are packed and it is influenced by the nature of compaction adopted in the mix. However, any aggregate with a particle density less than 200kg/m^3 is defined as light weight aggregate. Thus the aggregates used for this research work are normal weight aggregate (Clarke, 1995)

Table1: Physical properties of constituent materials

Parameters	Sand	Quarry dust
Specific gravity	2.62	2.67
Compacted Bulk density	1618.30kg/m^3	1991.88kg/m^3
Uncompacted bulk density	1467.30kg/m^3	1811.41kg/m^3
Moisture content	7.68%	0.4%
Coefficient of uniformity(C_u)	1.67	8.67
Finess modulus	4.28	6.01
Coefficient of concavity (C_c)	1.45	0.46

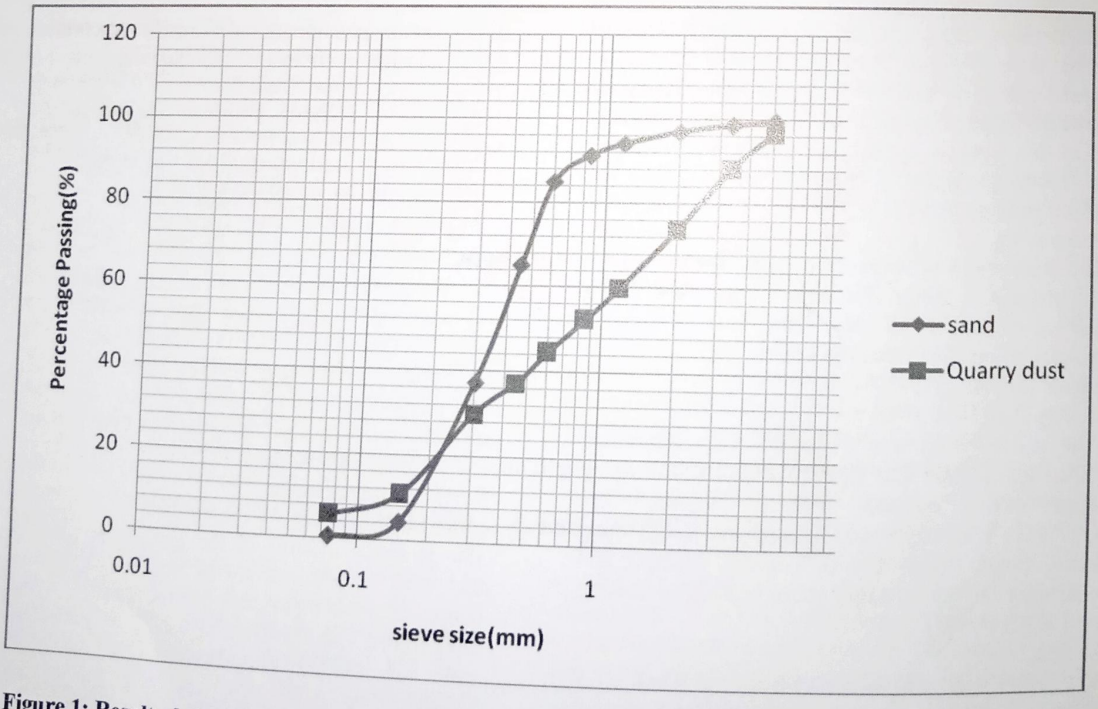

Figure 1: Result of sieve analysis of fine aggregates (Sand and Quarry dust)

Compressive strength

The compressive strength and density of the block increase along with the increase in quarry dust replacement, and with curing age. Figure 2 is a graphical representation of 28 days compressive strength which indicate that the compressive strength which indicate that the compressive strength increase steadily with the increase in the quarry dust content up to 30% replacement corresponding to the compressive strength of 2.2N/mm^2. The Standard Organization of Nigeria recommended that the minimum compressive strength of 18N/mm^2 and 2.2N/mm^2 for non-load bearing and load bearing hand compacted blocks respectively. Thus, this block certify the minimum standard of SON.

Thus, the quarry dust improves the compressive strengths of block made with the sand aggregate in zone 4. It can be concluded that quarry dust can lead to a significant improvement in microstructure due to different size fracture (i.e well graded). Also the finess in quarry dust particles tend to increase the amount of plasticizer needed for the quarry mixes in order to achieve a very good bond needed for the significant strength. The result of dry density was plotted graphically in figure 3. And the block can be classified as a dense weight block since it certify the specification of BS 2028,1364 (1968) which stated that the density of light weight blocks to be less than 1500kg/m^3 but greater than 625kg/m3 and that of dense block to be not less than 1500kg/m^3.

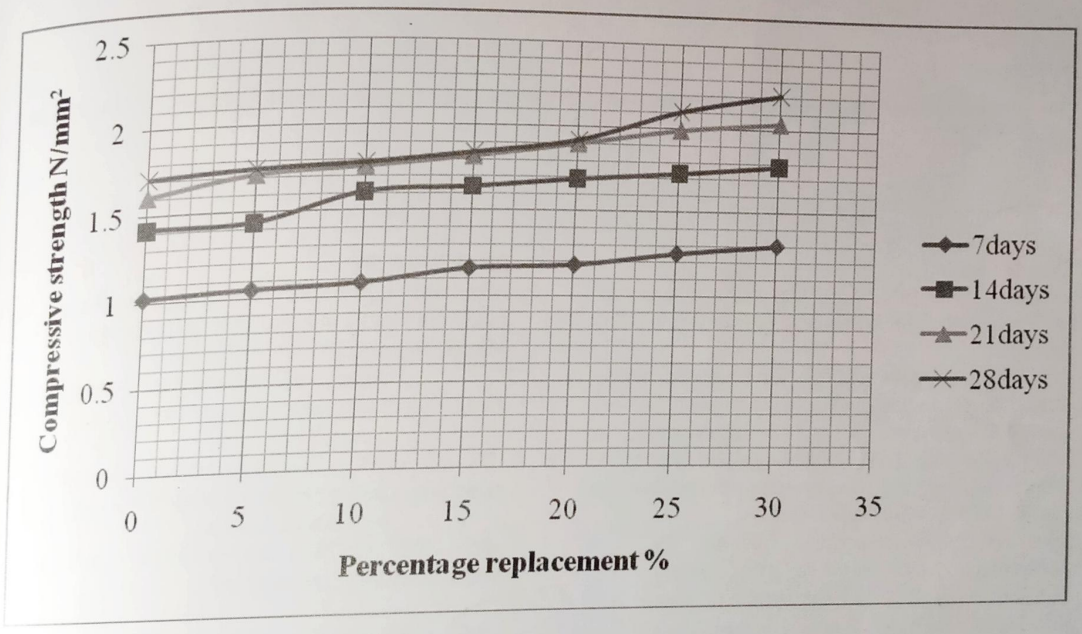

Figure 2: Relationship between compressive strength and percentage of quarry dust replacement for 7, 14, 21 and 28 days.

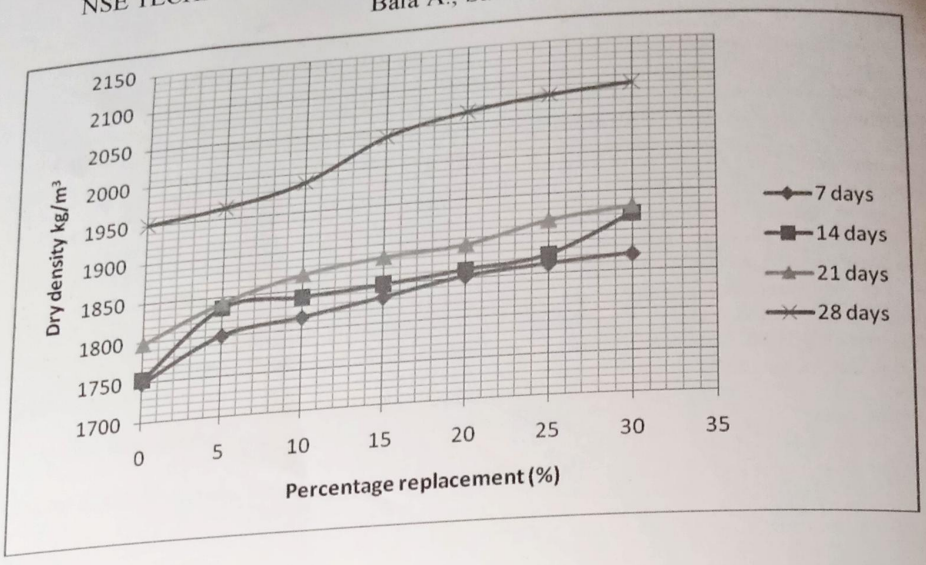

Figure 3: Relationship between Dry density and percentage of quarry dust replacement for 7, 14, 21 and 28 days.

Conclusions

Based on the laboratory test and the analysis of the results, the following conclusions were drawn;

The results of sieve analysis for sand and quarry dust conform to the grading requirements for fine aggregate in zone 4 and 2 respectively, in accordance with NIS 87:2004 and BS 882:1978, which indicate that quarry dust is suitable for blocks making while sand is not.

The density corresponding to the 28 days compressive strength of 15% quarry dust replacement is 2038.95kg/m^3 which is greater than 1500kg/m^3. Hence the block is a dense block.

The compressive strength and density increase with increased in the quarry dust content and the curing age. Adequate compressive strength was achieved for quarry dust replacement in the range of 15 to 30%.

4. The compressive strength of 1.71N/mm^2 for sandcrete block produced from 100% sand in zone 4 falls below 1.8N/mm^2 which is the minimum standard requirement of Nigeria Industrial Standard (NIS 87:2004). Therefore, the aggregate is not reliable for blocks making. Thus partial replacement with quarry dust can improve the quality of sand in zone 4 for block production.

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