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EFFECTS OF MAGNETIZED WATER ON THE ENGINEERING PROPERTIES OF SANDCRETE BLOCKS

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ABSTRACT

In this research, the effects of magnetized water on the engineering properties of sandcrete blocks was studied, in order to obtain efficient sandcrete blocks with relatively high levels of strength in comparison to that of potable water and at a lower cost. Values and results were determined from the experiments conducted. The magnetized water was made by passing potable water through a tube covered with magnets in order to create a magnetic field. a sandcrete mix was prepared, one without magnetized water and one with it. Sieve analysis and compressive strength tests were carried out on the mix and it was found out that the sandrete block produced by magnetized water increases the compressive strength of the sandcrete which will explain in detail why magnetized water should be a parmanent substitute to potable water and also a long term solution to the construction problems faced in the sandcrete block industry.

KEYWORDS: Magnetized water, Compressive strength, Sandcrete blocks, Sieve analysis, Chemical properties, Block production

1. INTRODUCTION

The general collapse of sandcrete blocks is mostly due to the failure of the mix in reaching the required strength of the sandcrete block during production. The quality of a sandcrete blocks is heavily dependent on the water and its constituents. Water to cementitious materials ratio is of utmost importance to ascertain the strength and longevity of sandcrete block, with that in mind, the necessity of quality water in assuring the longevity of the mix is encouraged Water chemistry (mineralogy, types of ions present, total dissolved solids, pH, etc.) is a key factor in concrete production that affects the mechanical properties of concrete, namely its compressive strength, flexural strength, water absorption, workability, and durability. However, few investigations had been conducted on the effect of magnetized water on the mechanical properties of sandcrete block mixes to properly ascertain its effects.Water is an necessary constituent of Sandcrete as it will actively participates in the chemical reaction with cement.[11]

It controls the hydration of cement, workability, microstructure, strength and overall durability of concrete. Water used for manufacturing as well as curing of concrete should be clean and free from oils, acids, alkalis, salts, organic materials and any substance that affects the properties of concrete. Generally the water used for making the concrete is potable tap water.[10] Some researchers have used magnetized water in the preparation of concrete. Magnetized water is formed by passing the water through a magnetic field of certain strength under specific conditions. Generally, when water gets magnetized, there is a reduction in the surface tension of water which is measured using the apparatus called Tensiometer.. The reduction in the surface tension of water provides the breakage of large water clusters into smaller water clusters. This leads to the change in the trajectory of water particles providing much better bonding between the other materials added to the water.[5] and faster and complete hydration of cement takes place . This leads to the improved engineering properties of concrete. the effect of a static magnetic field on liquid water, and suggested that stronger hydrogen bonds –which lead to a higher viscosity- was formed due to the broken hydrogen bonds after magnetization. Water molecules tend to form clusters with hydrogen bonds, while these clusters are broken due to the magnetic field when applied, hence increasing the water activity. Due to the smaller size of magnetized water molecules, the water layer surrounding the Sandcrete is thinner than potable water molecules, therefore less water demand, which has a positive effect of hardened Sandcrete properties, Magnetized water has different mechanical, electromagnetic, and thermodynamic properties compared to regular tap water . Due to these specific properties, the use of magnetized water has been increasing in different applications such as in industrial, environmental, medical, and agricultural fields due to the development of magnetic devices. The magnetization procedure of water is a simple method without using extra energy when a permanent magnet is used. The permanent magnet can be installed on a previously established water tube system, resulting in no further energy requirements for water magnetization.

In Nigeria, 95% of walling materials in buildings are made of sandcrete blocks.[7] put forward that Sandcrete walls have adequate strength and stability, provide good resistance to weather and ground moisture, durable and easy to maintain. They also provide reasonable fire, heat, airborne and impact sound resistance. As material for walls, its strength is less than that of fired clay bricks, but sandcrete is considerably cheaper.[2] argued that sandcrete is the main building material used for the construction of walls of most post-independent buildings in Nigeria. In many parts of Nigeria, sandcrete hollow blocks are the major cost component of the most common buildings. The blocks are usually manufactured with the use of a vibrating machine. A new technology developed in South Africa but now used in several parts of Africa known as hydraform technology is also used in manufacturing sandcrete blocks in Nigeria.[9]

Hydraform block, usually solid, is a type of sandcrete block that could be stacked together to form a wall without cement. hydra comes from Hydraulic indicating the hydraulic action in manufacturing blocks,while form comes from the formation of interlocking blocks.The main benefit of using Hydraform ‗Interlocking' Block for a walling unit is that the interlocking blocks are dry stacked meaning no mortar is required in 70% of the structure.[8] opine that the Hydraform interlocking blocks lock front and back, top and bottom eliminating the need for mortar joints in the super structures.

The reported effects of magnetic water treatment are varied and often contradictory. In many cases, researchers report finding no significant magnetic treatment effect. In other cases, reasonable evidence for an effect is provided. The Australian Fluid Energy.[12] mentions that the molecule groups of magnetic water differ from molecule groups of ordinary water in having lower degree of consolidation, and the molecules volume is more uniform.[1] proposed magnetic field effect on hydrogen bonds between water molecules and found some exchange which happened in the properties of water such as light absorption, surface tension and pH.

Several studies had been done on the effect of magnetized water on cement paste and concrete properties. Magnetic treatment, using three different magnetic induction strengths, was carried out by.[4] 2014 on cement pastes after mixing and casting in a controlled environment. For this particular study, samples were cured in wet conditions and revealed that the rate of hydration as well as setting time were accelerated and the heat of hydration was increased with respect to the samples not subjected to magnetic.[4] The test also confirmed porosity reduction with magnetization treatment, but it had no effect after 7 days of complete hardening.[3] Another experiment suggested the application of the magnetic field on a pipe while pumping concrete in place.

Tests conducted on real size pumping circuits of length 1000m with a pipe diameter of 125 mm showed that this procedure improved concrete pump-ability due to the change in the lubricant layer properties between the interface of the concrete and the pipe wall, the thickness of this layer was measured using an ultrasonic velocity profiler.[6]

2. EXPERIMENTAL WORK / METHODOLOGY

Materials

Cement: the cement used throughout this work is the ordinary Portland cement (O.P.C) produced in Nigeria by dangote cement plc, the physical test will be conducted on the cement. It must conform to the Nigeria Specifications.

Fine aggregate (sand): river sand from Edo state was used, with specifically good quality.

Magnetized Water: water is needed for the chemical process (hydration) in which the cement powder sets and hardens into one solid mass. Drinking water from nearby well was magnetized and used throughout this research and potable water was also used.

Mold: The 6 inches (225×150×450mm) is used for the production of our sandcrete block, it was collected from the civil engineering laboratory of Benson idahosa university and the dimensions were taken so as to calculate the volume of our block.

Dimension Check: The dimensions (length, height, thickness, web thickness) of the blocks were measured. This was done in order to determine the extent of deviation of the blocks from the standard work size specified by the NIS.

Preparation of Magnetized Water

The Chamber for the preparation of magnetized water consist of a plastic container which allows water to run through and pointed hole serves as outlet for water to be treated. Water was allowed to run out of the hole and pass through the pipe which holds the magnet arranged in series to form a magnetic field and thus the water is magnetized. The water was then collected through the outlet and was used for the production of the sandcrete blocks.

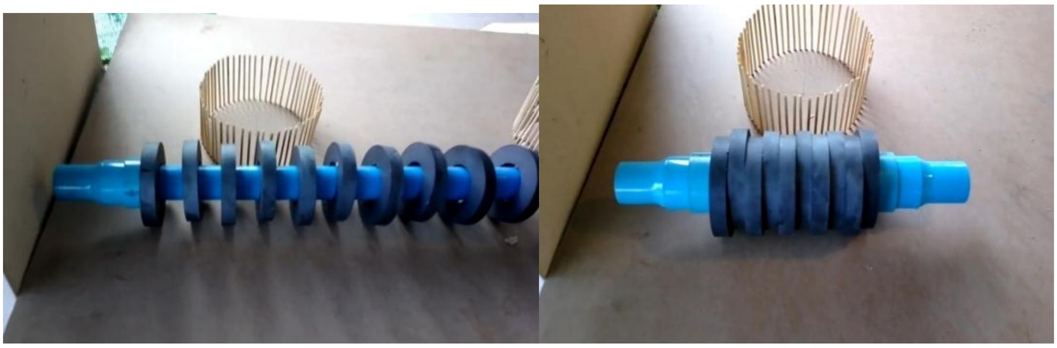

Figure 2.1: Magnets Before And Glue Is Applied.

Production of sandcrete block

A recommended mix ratio of 1:6 (one part cement and six parts fine aggregate)was used in the experiment, 44kg of Cement is required to produce 15 blocks while for the potable Water Sandcrete block, 260 kg of sand is required to produce 15 blocks and our water/cement ratio is specified as 0.5.

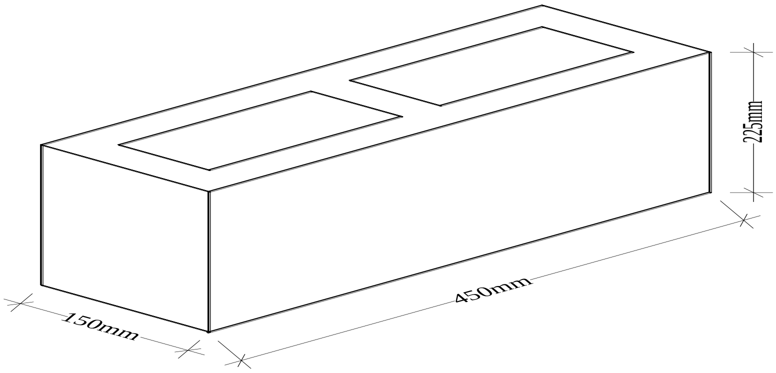

Figure 2.2: 6 inches Hollow Sandcrete Block.

Sieve Analysis Test: sieve analysis was carried out on the aggregate samples in order to determine their suitability for the block production. The test involves pouring the aggregate sample on a set of standard test sieves arranged in order of decreasing aperture. The arrangement was then shake vigorously and the weight of samples retained on each sieves was recorded. The percentage of the sample retained on each sieves was then computed.

$$\% \, Retained \, on \, each \, seive = \frac{weigth \, of \, sample \, retained}{Total \, weigth \, of \, sample} \times 100\%$$

Table 2.1: Grading Requirement for Fine Aggregate.

Sieve Size BS	ASTM No.	Percentage weight passing sieves BS 882: 1992				ASTM C 33-93
		Overall Grading	Coarse Grading	Medium Grading	Fine Grading	
10mm	$\frac{3}{18}$ *in*	100				100
5.0mm	$\frac{3}{16}$ *in*	89-100				95-100
2.36mm	8	60-100	60-100	65-100	80-100	80-100
1.18mm	16	30-100	30-90	45-100	70-100	50-85
600mm	30	15-100	15-54	25-80	55-100	25-60
300mm	50	5-70	5-40	5-48	5-70	10-30
150mm	100	0-15				2-10

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 2028 using the compressive testing machine. The load at failure of the blocks were recorded and the compressive strength was determine from the relation:

$$Compressive\ Strength\ (N/mm^2) = \frac{Maximum\ load\ at\ failure(N)}{Cross\ sectional\ Area\ (mm^2)}$$

3. DATA ANALYSIS AND DISCUSSION OF RESULTS

3.1 Sieve Analysis Test

The sieve analysis results are shown in table 4.1 and the particle size distribution curves of the sand are shown in fig 4.1. The result shows that all the aggregates sample satisfied the overall grading limit according to BS 882: 1992 the aggregates are therefore suitable for block making purpose.

Table 3.1: Sieve analysis result of aggregate.

Sieve Size (mm)	Weight Retained (g)	% Weight Retained	Cumulative % Retained	%Passing
5.00	57.3	11.46	11.46	88.54
3.35	19.8	3.96	15.42	84.58
2.36	22.7	4.54	19.96	80.04
2.00	17.1	3.42	23.38	76.62
1.18	50.8	10.16	33.54	66.46
0.85	48.1	9.62	43.16	56.84
0.6	74.9	14.98	58.14	41.86
0.425	68.0	13.60	71.74	28.26
0.3	49.9	9.98	81.72	18.28
0.15	59.7	11.94	93.66	6.34
0.075	18.6	3.72	97.38	2.62
Pan	11.7	2.34	99.72	0.28

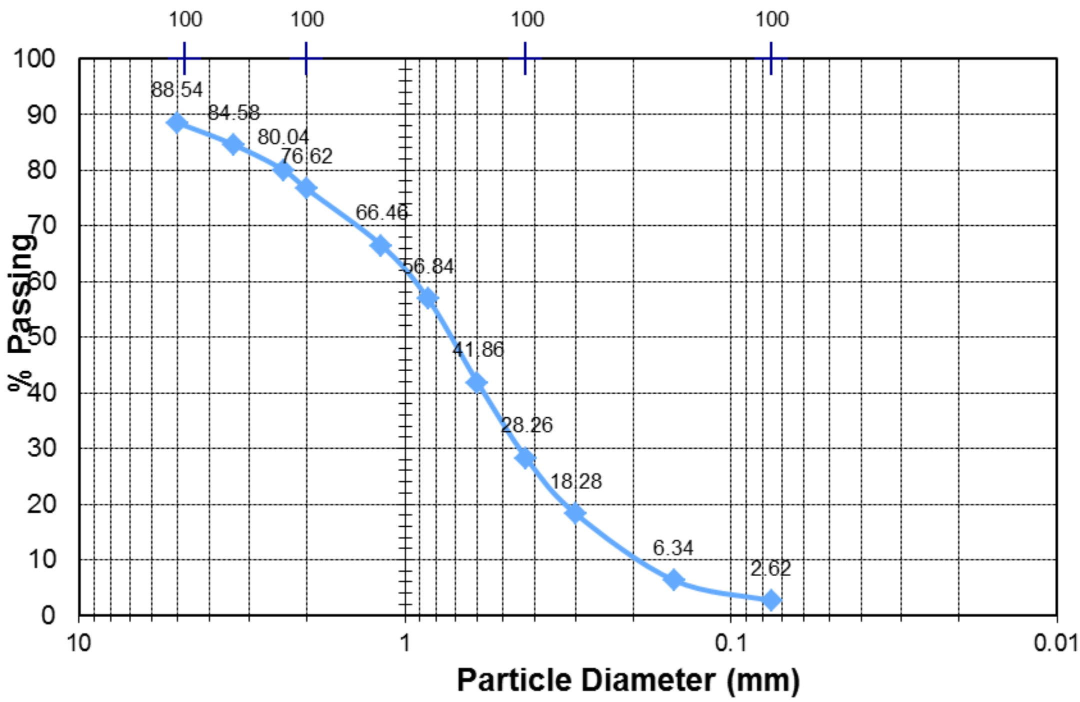

Figure 3.1: Particle Size Distribution Curve of Aggregate (Sand).

Coefficient $\frac{D_{30}}{D_{60}}$

From graph

Effective

From size $= D_{10}$

$$C_U = \frac{D_{60}}{D_{60}\ D_{10}}$$

$D_{10} - 0.18$

$D_{30} - 0.42$

$D_{60} - 0.90$

C_U (Cefficient of uniformity) $= \frac{D_{60}\ 0.90}{D_{10}\ 0.18} = 5.0$

$$C_U\ (\text{Cefficient}) = \left(\frac{D_{30}^{\ 2}}{D_{60}\ x\ D_{10}}\right) = \left(\frac{0.42^{\ 2}}{0.90\ x\ 0.18}\right) = \frac{0.176}{0.162} = 1.088 = 1.1$$

3.2 Laboratory test on magnetized water

The average results of the physical and chemical properties of magnetized water is as shown in Table 3.2

Table 3.2: Chemical Properties of Magnetically Treated Water.

	K	Ca	Mg	Fe	Mn	Mn	No^{-N}	P_{04}^{-P}
Control	9.09	32.055	4.925	0.07	0.085	0.045	0.425	0.015
Run 10	8.455	41.43	8.195	0.055	0.095	0.085	0.515	0.025
Run 15	10.66	38.635	6.415	0.075	0.115	0.095	0.465	0.02
Average	9.5575	40.0325	7.305	0.0925	0.105	0.09	0.49	0.0225

3.2.1 DISCUSSION

The following are the discussed values of the result (Table 4.2) of the elements present in the magnetized water and comparing them with magnetized guideline standard

- **Potassium (K)**

The potassium (K+) cation behaves similarly to sodium in the soil and is commonly found in natural waters in only small amounts. The result shows that potassium content in the magnetized water increases (9.090 ppm – 10.66 ppm) as the runs of water increases. This is within the range of the magnetized water guide standard.

- **Calcium (C^+)**

Ca+ also increases to 40ppm in the 'run 10', the standard for calcium is 40 ppm – 120 ppm. It shows that the magnetic field has helped the magnetized water to fall within required range which will enhance the paving stone.

- **Magnesium (Mg^{++})**

The magnesium (Mg^{++}) cation is also found in most natural waters. Together with calcium, Mg may be used to establish the relationship to total salinity and to estimate the sodium hazard. The result shows that magnetic field helps the water to fall within the standard range.

❖ **Iron (Fe^{++})**

The Iron (Fe++) cation can be problematic in many magnetized water. Excess iron can compete with other needed micro-nutrients and can cause staining of walkways or road surfaces. Magnetic field reduces the iron content of the water since iron is dangerous to the water.

❖ **Manganese**

Manganese value also increases from 0.08 ppm to 0.11 ppm which is of high benefit to the crops. The value is within the standard range.

❖ **Zinc**

Zinc increment is not significant has the increment is still within the range specified by the magnetized water guideline.

3.3 Compressive Strength Test

The compressive strength tests were carried out at 7, 14, 21 and 28 days of moulding the sandcrete blocks using compressive testing machine.

$$Compressive\ Strength\ (N/mm^2) = \frac{Maximum\ load\ at\ failure(N)}{Cross\ sectional\ Area\ (mm^2)}$$

Where Cross Sectional Area = Total Surface Area of Block(mm^2) – Area of Hollow (mm^2)

Table 3.11: Average Compressive Strength of both Sandcrete Blocks made with Potable Water and Magnetized Water.

S/No.	Period of Test (Days)	Average Compressive strength (N/mm^2) of Blocks made with Potable Water	Average Compressive strength (N/mm^2) of Blocks made with Magnetized Water
1	7	2.32	2.61
2	14	2.58	2.72
3	21	2.59	2.89
4	28	2.83	2.96

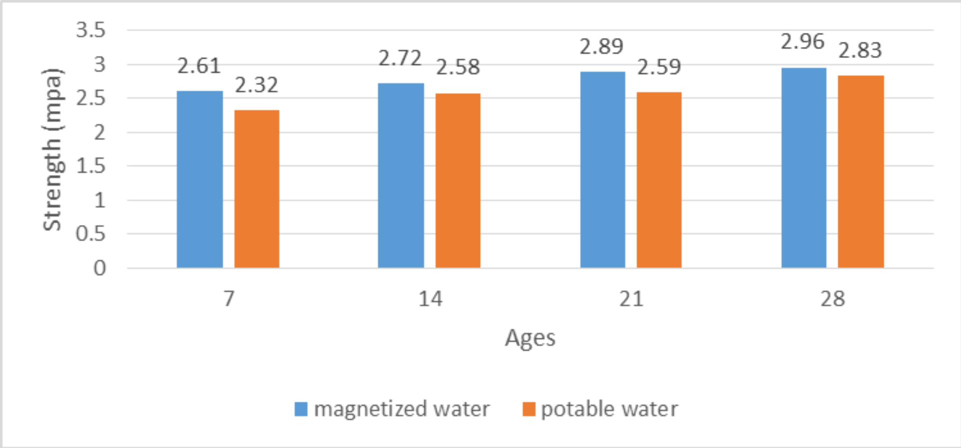

Figure 3.1: Strength variation of sample with strength of sandcrete.

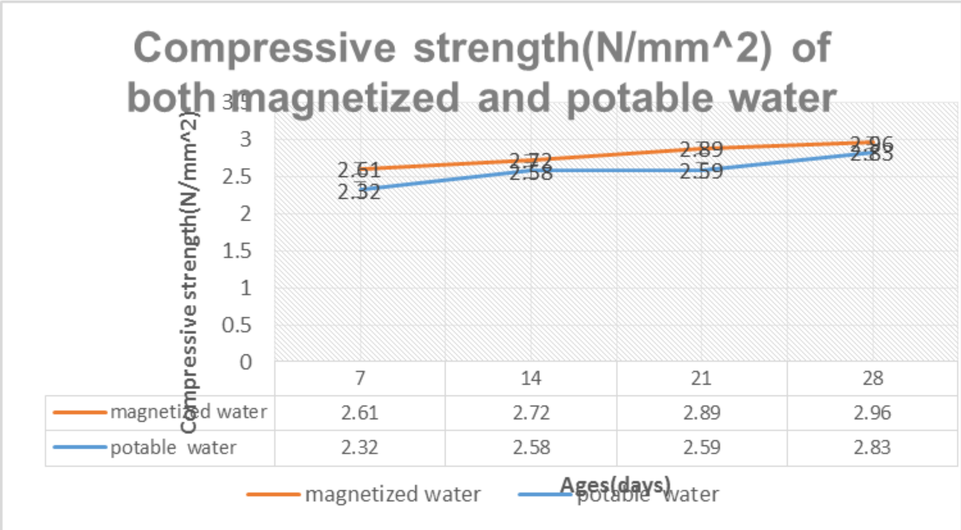

Figure 3.2: Comparative graph of the compressive strength of both magnetized and potable water.

4.0 CONCLUSIONS

4.1 Conclusions

The following conclusions can be drawn from the results obtained in this research

1. The grading of the aggregates used for the block production are within the limits specified in BS 882: 1992 where the coefficient of uniformity of the sample is less than (4), hence the classification of which says that the soil is well graded, D_{1O}/D_{60}=1.1, the aggregates therefore are suitable for block making.
2. The magnetized water has a greater compressive strength than potable water making it more suitable for construction works.
3. The magnetized water contains some other chemical properties which are very useful for engineering works more than the potable water.

4. The average compressive strength of potablel Water Sandcrete blocks at the ages of 7, 14, 21 and 28 days varies between 2.32N/mm^2 to 2.83N/mm^2 which is below the minimum NIS standard of 2.5N/mm^2 and 3.45N/mm^2 for individual and Average compressive strength of the blocks respectively while the compressive strength of Magnetized Water Sandcrete Block blocks at the ages of 7, 14, 21 and 28 days varies between 2.61N/mm^2 to 2.96N/mm^2.
5. Hence, it can be concluded that, generally magnetized water lead to an improvement in Construction works.

Recommendation

Magnetized Water should be produced in large amount to encourage the use in construction activities.

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